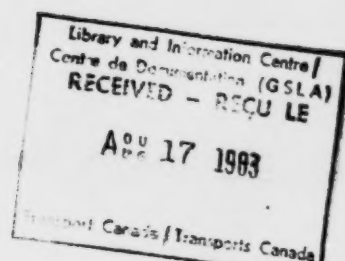


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C5
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TABLE OF CONTENTS



PAGE

1.0 INTRODUCTION	1
2.0 METHODOLOGY	2
2.1 List of Interviewees	2
2.2 Interviews	3
2.3 Interview Write-ups	4
2.4 Future Updates of the Compendium	4
2.5 Cross Referencing System	5
2.6 Study Limitations	5
3.0 SUMMARY	6
3.1 Governments and Research Councils	6
3.2 Carriers	7
3.3 Equipment Manufacturers	8
3.4 Universities	8
3.5 Associations	9
4.0 PROJECT SUMMARIES	10
4.1 Governments and Research Councils	10
a) Federal Government	11
Transport Canada	11
Research and Development Directorate	11
Transportation Development Centre	14
Road Safety Directorate	17
Energy Planning Directorate	18
Economic Analysis Directorate	19
Canadian Transport Commission	20
Energy, Mines and Resources	21
Transportation Energy Division	21
National Research Council	23
Division of Mechanical Engineering	23
Division of Energy, Research and Development	24
National Defence	26
Industry, Trade and Commerce	28

TABLE OF CONTENTS (continued)

	<u>PAGE</u>
b) British Columbia Government	30
Energy, Mines and Petroleum Resources -	
Conservation and Renewable Energy Branch	30
Universities, Science and Communication	31
Transportation and Highways	32
B.C. Research	33
c) Alberta Government	35
Transportation - Research and Development Branch	35
Energy and Natural Resources - Conservation Branch	36
Economic Development - Transportation Services	37
Alberta Research Council	38
d) Saskatchewan Government	39
Highways and Transportation	39
Saskatchewan Power Corporation	40
Transportation Agency	41
Saskatchewan Research Council	42
e) Manitoba Government	43
Energy and Mines	43
Highways and Transportation	44
Industrial Technology Centre/Manitoba	
Research Council	46
f) Ontario Government	47
Transportation and Communications	48
Energy	51
Ontario Energy Corporation	52
Ontario Research Foundation	54
g) Quebec Government	56
Transports	56

TABLE OF CONTENTS (continued)

	<u>PAGE</u>
h) New Brunswick Government	58
Transportation	58
Energy Secretariat	58
i) Nova Scotia Government	61
Mines and Energy	61
j) Prince Edward Island Government	63
Transportation and Public Works	63
k) Newfoundland Government	64
Transportation	64
Energy and Mines	64
4.2 Carriers	65
Air Canada	66
Canadian National	68
Canadian Pacific	70
Reimer Express Lines Ltd.	72
Voyageur Inc.	73
4.3 Equipment Manufacturers	74
Bombardier - Rail and Diesel Products Division	75
Canadian Fram Limited	77
Canadian Methanol Canadien	79
Canertech Inc.	80
Chrysler Canada Limited	82
Cummins Diesel of Canada Limited	84
Du Pont Canada Inc.	85
Ethyl Canada Inc.	86
Ford Motor Company of Canada Limited	88
General Motors of Canada Limited	90
International Harvester Canada Limited	91
KHD Canada Inc.	92
Massey-Ferguson Limited	93
Pratt & Whitney Aircraft of Canada Ltd.	95
Urban Transportation Development Corporation Limited	96

TABLE OF CONTENTS (continued)

	<u>PAGE</u>
4.4 Universities	98
University of British Columbia - Centre for Transportation Studies	99
University of British Columbia - Mechanical Engineering	100
University of Calgary - Institute for Transportation Studies	101
Canadian Energy Research Institute (University of Calgary)	102
University of Manitoba - Centre for Transportation	104
University of Toronto - York University Joint Program in Transportation	105
Canadian Institute of Guided Ground Transportation (Queen's University)	108
Carleton University - Transportation Research Centre	110
University of Montreal - Ecole Polytechnique - Civil Engineering Department	112
University of Montreal - Centre de Recherche sur les Transports	114
Laval University - Mechanical Engineering Department	116
University of New Brunswick - Transportation Group	118
Technical University of Nova Scotia - Centre for Energy Studies	119
Canadian Marine Transportation Centre (Dalhousie University)	121
4.5 Associations	123
Air Transport Association of Canada	124
Canadian Automobile Association	125
Canadian Motor Coach Association	127
Canadian Trucking Association	128
Canadian Urban Transit Association	130
Dominion Marine Association	131
Motor Vehicle Manufacturers' Association	132
Private Motor Truck Council of Canada	133
APPENDIX A (Letter to Interviewees and RTAC Letter of Introduction)	135
SUBJECT INDEX	138

1.0 INTRODUCTION

The Technical Committee on Transportation and Energy, of the Roads and Transportation Association of Canada (RTAC), has long recognized the need for means of sharing information on current projects and activities amongst practitioners in the transportation and energy field. After debating the best way of fulfilling this need, the RTAC Committee decided that an inventory of current and planned energy-related transportation research, development, and demonstration activities was appropriate. The Research and Development Directorate of Transport Canada agreed to provide the funds and the Energy Planning Directorate of Transport Canada agreed to manage this initial inventory project. Canadian Resourcecon Limited, in association with Douglas Whitehead Consultants, was selected as the contractor for preparation of an inventory and began work in December, 1982.

Certain parameters of the inventory should be made clear from the outset. Many of the projects listed in the compendium are not strictly energy-related transportation research, development or demonstration projects. The projects generally refer to the utilization of energy in transportation and not the supply of energy or the transport of energy commodities. What is listed are the energy-related transportation activities as reported by the people interviewed; in some instances the projects are operational changes, introduction of new energy efficient equipment and energy conservation promotions. Also the reader should be aware that modestly funded projects are displayed as prominently as projects with major funding. The reader is directed to Section 3.0, Summary, for a commentary on the relative importance of different programs and projects.

This document is intended to communicate to people interested in the energy and transportation field information on "who is doing what" in Canada regarding energy-related transportation research. Names, addresses, and telephone numbers are given of contact people at each of the institutions/agencies canvassed. The intention is that this initial compendium will be updated at regular intervals.

2.0 METHODOLOGY

The approach of the study was to collect information from the principal practitioners in the transportation and energy research fields in Canada by face-to-face interviews. Telephone interviews were used for those individuals who could not be visited directly. The specific steps in the study process were:

- (i) Develop a list of institutions/agencies and individuals to contact.
- (ii) Develop the interview format.
- (iii) Contact the interviewees, arrange an interview schedule and carry out the interviews. Follow-up with telephone calls where necessary.
- (iv) Develop the format of the final report and write the report.

2.1 List of Interviewees

The list of individuals and institutions to be interviewed was developed by the consultants in consultation with the members of RTAC's Technical Committee on Transportation and Energy. The Committee members represent a wide cross-section of transportation/energy researchers in every province of Canada and were able to suggest many individuals and institutions to the consultants. The interview list included the following categories of institution:

(i) Governments:

Provincial departments of transportation and energy
Federal government departments and agencies
Crown corporations concerned with transportation and/or energy
Provincial research councils

(ii) Carriers:

From every transportation mode, major carriers known to be involved in energy-related projects.

(iii) Manufacturers:

Transportation equipment manufacturers (including automobile manufacturers) who have energy programs.

(iv) Universities:

Centres for Transportation
Engineering departments with transportation specialization
Energy Institutes

(v) Associations:

Industry associations active in the transportation energy area, e.g., Canadian Automobile Association, Canadian Trucking Associations, etc.

About 80 names were included in the final list.

2.2 Interviews

The interviewees were sent a letter approximately two weeks in advance of the proposed interview explaining that an inventory of energy-related transportation activities was being prepared and that the consultant would telephone to arrange an interview. A letter of introduction on RTAC's letterhead accompanied the consultant's letter and asked for the interviewee's cooperation. Both the consultant's letter and RTAC's letter of introduction are contained in Appendix A.

Interviews were conducted during the period January to March 1983, and interviewees were asked to provide the following details with respect to their energy-related R&D activities:

- general programs and description
- specific projects and brief descriptions
- documentation available
- contact persons
- budgets, expenditures
- cooperative research with other organizations
- future plans

Without exception, the individuals interviewed gave freely of their time and generally provided the information requested. In some instances information on expenditures and budgets was either unavailable or held to be confidential.

2.3 Interview Write-ups

Section 4.0 contains the write-ups of the individual interviews: each institution/agency is written up separately and, in most instances, represents an individual interview. Section 4.0 is organized in the following order - governments, carriers, manufacturers, universities, associations. Each write-up is organized under the following headings:

- Background
- Projects
- Funding
- Contact Persons
- Publications

No quantitative analysis of interview information (e.g., expenditures by type of project) has been undertaken. The information does not lend itself to quantitative analysis particularly since expenditure information is incomplete. Section 3.0, however, contains a summary that gives the reader an overview of the major programs and trends.

2.4 Future Updates of the Compendium

If the compendium is to serve its function properly as an information clearing house, it will need regular updating. The expectation is that institutions/agencies appearing in Section 4.0 will be asked to revise their write-up to include a current list of projects and any other changes at regular intervals. Any institutions/agencies which are not included in the present compendium and wish to be included in future editions should make their interest known to the Roads and Transportation Association of Canada (RTAC).

2.5 Cross Referencing System

In order to assist the reader in using the compendium, a subject index has been prepared which cross references institution/agency projects by subject matter. This index is located at the end of the compendium.

2.6 Study Limitations

No rigorous definitions of what constitutes energy-related research, development, and demonstration were imposed on those who were interviewed. What has been reported under the "Projects" heading is what was reported in the interviews as energy-related activities. In the letter to interviewees, the consultants stressed that "programs and projects of interest in the survey are programs of transportation R&D where the primary purpose is energy-related". Many of the projects identified by the interviewees have overall efficiency or productivity improvement objectives with increased fuel efficiency as a secondary or peripheral objective; these projects have been included even though energy conservation is not their prime objective.

The project listing for each institution/agency gives current projects; however, in some instances projects completed in earlier time periods have also been listed. Consequently, the time period for the reported projects is not consistent from entry to entry. Future up-dates of the compendium should attempt to rectify this and report fully on noteworthy projects completed in earlier time periods.

The Interprovincial Advisory Committee on Energy (IPACE) initiated a survey of research and development on alternate transportation fuels in early 1982 (Middleton Associates, Compendium of Federal and Provincial Programs/Projects and Alternative Transportation Fuels, November 1982). The list of projects from the IPACE survey has been incorporated into Section 4.0. The reader is directed to Dr. Roger Higgins, Ontario Ministry of Energy, for information on the availability of the IPACE survey.

As mentioned above, the list of interviewees was developed largely on the basis of a canvassing of the membership of RTAC's Technical Committee on Transportation and Energy. Almost certainly groups have been missed that should have been included; for these oversights the authors and the Committee apologize. The intention is, however, to update the compendium on a regular basis and anyone who wishes to have their activities included in future editions should contact the Roads and Transportation Association of Canada.

3.0 SUMMARY

3.1 Governments and Research Councils

The Federal government is the major actor in the transportation and energy field - most importantly as a source of funding for projects where the performers are industries, consultants, research institutions, and universities. The increased emphasis on and funding of energy R&D by the Federal government in the mid 1970's (Panel on Energy R&D) and the additional energy R&D funding that constituted part of the National Energy Program (1980) have financed much of the energy-related transportation activities in Canada. The two key groups in the Federal government in terms of program/project development and overall coordination are Transport Canada's R&D Directorate (Energy R&D Branch) and EMR's Transportation Energy Branch. Anyone outside the Federal government planning an energy-related transportation project is advised to make contact with these two groups in order to avoid duplicating existing research and also to explore the possibility of Federal cooperation and funding.

The Ontario government activities are substantial in the energy and transportation field. MTC's Transportation Energy Management Program (TEMP) has developed successful information and demonstration programs (e.g., Drive Save, Truck Save, and Drive Propane) as well as more fundamental basic and applied research on energy conservation and alternative fuels. Other provincial governments are advised to keep abreast of Ontario's TEMP program as many of its findings and materials may be transferable to their own jurisdictions.

Research Councils play an active role in the energy and transportation field; in particular certain Research Councils have developed expertise in specific areas. Of note are the National Research Council with its laboratory activities in engines, fuels (including the hydrogen program), and lubricants; Ontario Research Foundation and its alternate fuel utilization research; Manitoba Research Council (Industrial Technology Centre) and its vehicle demonstrations and biomass fuels; and B.C. Research and its work in compressed natural gas.

3.2 Carriers

Rapidly increasing fuel costs in the late 1970s and early 1980s alerted transportation carriers to the need to improve their energy efficiency. Generally carriers (all modes) have responded by testing available energy conservation equipment and operating techniques and adopting those that were appropriate in their individual needs.

Railways (e.g., Canadian National and Canadian Pacific) maintain corporate research and development groups which carry out R&D projects in conjunction with their operating companies. Although some of these activities may be classified as R&D (e.g., engine developments and fuel type tests) the main focus is on energy conservation and improved energy efficiency through practical changes to equipment and operating procedures.

Fuel costs are a critical operating cost for air carriers; as a result, air carriers have already adopted operational changes (e.g., reduced speed, computerized climb, and descent procedures) to save fuel. Replacement of existing aircraft with new, more fuel efficient aircraft remains the most likely area for future fuel savings.

Trucking and bus companies have reviewed their fuel conservation options and have adopted equipment add-ons and made operational changes as appropriate. Government informational programs such as "Truck Save" and "Drive Propane" (Ontario Ministry of Transportation and Communications) have been useful to the industry.

3.3 Equipment Manufacturers

A substantial amount of proprietary energy-related research is undertaken by equipment manufacturers. For the automobile and truck manufacturers, most of the research takes place in the United States; an exception is the alternate fuels area where Chrysler, Ford, and General Motors are all introducing propane vehicles for Canadian operations. Some Canadian-based engine developments are being undertaken, e.g., KHD Canada's air-cooled diesel engine and Bombardier's new railway locomotive. Canadian Fram is an example of an automotive supply company with research directed toward energy-saving automotive accessories.

Canertech Inc. and the Urban Transportation Development Corporation Limited are examples of companies with direct government backing that are engaged in developing new products through R&D activities.

3.4 Universities

Energy-related transportation research is a secondary activity with most of the university "centres for transportation". Their research programs cover a wide range of transportation problems but seldom is an energy-related issue the prime reason for the research. The one exception is in the area of engine and fuels testing where much research is directed to the use of lower quality fuels and alternative transportation fuels.

The Technical University of Nova Scotia has successfully demonstrated that significant fuel savings are possible through an automobile tuning program; this program provides a cost savings to motorists and has the potential of expansion to other Canadian locations. This program is an example of the type of effective energy-related transportation activity that can be handled by the universities.

3.5 Associations

The transport-industry associations act as a source of information for their members on energy-related issues. By and large the associations do not engage in energy-related R&D activities directly; in a number of instances associations act in an advisory role presenting their industry's views on R&D projects to governments.

4.0 PROJECT SUMMARIES BY INSTITUTION/AGENCY

4.1 Governments and Research Councils

Federal Government

Background

The Federal Government is a major actor in the energy-related transportation R, D & D field. In large measure the relatively high level of Federal activity results from the creation of the Panel on Energy R&D (PERD) in 1975 in response to higher energy price and the perceived need for an increased level of energy research in Canada. PERD is an interdepartmental committee chaired by Energy, Mines and Resources (EMR) and is responsible for planning, organizing and funding the Federal Government's energy R, D & D activities. (The Panel has a permanent secretariat within EMR called the Office of Energy R&D). PERD has identified six tasks - Conservation, Oil Sands/Heavy Oil and Coal, Nuclear Energy, Renewable Energy, New Liquid Fuels and Conventional Energy Resources - and under each of these tasks are a number of programs (see Figure 1). The three key programs of interest from a transportation and energy perspective are Conservation - Transportation (Program 1.5), New Liquid Fuels - Fuel Use (Program 5.5) and New Liquid Fuels - Hydrogen and Energy Storage (Program 5.6). Figure 2 lists the sub-programs under each of these three programs and gives departments and individuals responsible for the sub-program and any other departments which have projects under the sub-program.

The following is a department by department description of energy-related transportation activities. Nearly all of these activities fit into the programs and sub-programs as outlined in Figure 2 and are at least partially funded by the Panel on Energy R&D. As well, there are instances where departments fund energy-related transportation R&D from their own budgets.

Transport Canada - Research and Development Directorate

The Energy R&D unit within this directorate is responsible for programming of Transport Canada energy-related R&D activities. One of the main tasks is to act as the link between Transport Canada and PERD. As well, any energy-related R&D suggestions originating with Transport Canada's Advisory Boards (Highway, Air, Rail & Marine) find their way into the system via this directorate.

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FIGURE 1

Task and Program Structure - Interdepartmental Panel on Energy R&D (PERD)

Tasks and Programs

- 1.0 CONSERVATION**
 - 1.1 Industry Sector
 - 1.2 Buildings Sector
 - 1.3 Food Supply Sector
 - 1.4 Demand Management
 - 1.5 Transportation Sector*
 - 1.6 Management and Coordination Supply
- 2.0 OIL SANDS/HEAVY OIL AND COAL**
- 3.0 NUCLEAR ENERGY**
- 4.0 RENEWABLE ENERGY**
- 5.0 NEW LIQUID FUELS**
 - 5.1 Direct Liquefaction
 - 5.2 Gasification
 - 5.3 Biological Processes
 - 5.4 Fuels Processing
 - 5.5 Fuel Use*
 - 5.6 Hydrogen and Energy Storage*
 - 5.7 Environment
 - 5.8 Planning and Coordination
- 6.0 CONVENTIONAL ENERGY RESOURCES**

* Programs with energy-related transportation sector activities.

FIGURE 2

Transportation-Related Energy R&D Sub-Programs: Panel on Energy R&D

<u>Subprogram Titles</u>	<u>Participating Departments</u>
<u>CONSERVATION - TRANSPORTATION SECTOR (1.5)</u>	
Chairman - Dr. W.F. Johnson - Transport Canada	
1.5.1 Standards and Analytic Tools	- Transport Canada - EMR
1.5.2 Road Vehicles	- Transport Canada - EMR - NRC
1.5.3 Transport Systems	- Transport Canada - EMR
<u>NEW LIQUID FUELS - FUEL USE (5.5)</u>	
Chairman - Bernie James - EMR	
5.5.1 Vehicle System Technology (Coordinator - W.F. Johnson - Transport Canada)	- Transport Canada - DND
5.5.2 Fuel/Engine Combustion Technology (Coordinator - G.V. Maund - EMR)	- DND - Agriculture Canada - NRC - EMR - Transport Canada
5.5.3 Fuel Systems Technology (Coordinator - Bernie James - EMR)	- Consumer & Corporate Affairs - Transport Canada
5.5.4 Policy-Related Assessments (Coordinator - W.F. Johnson - Transport Canada and Bernie James - EMR)	- EMR - Transport Canada
<u>NEW LIQUID FUELS - HYDROGEN AND ENERGY STORAGE (5.6)</u>	
Chairman - J.B. Taylor - NRC	
5.6.1 Hydrogen Production	- NRC
5.6.2 Hydrogen Utilization	- NRC - EMR - DND
5.6.3 Energy Storage	- EMR - Transport Canada - NRC
5.6.4 Electro-chemistry Centre	- NRC

Federal Government (continued)

Transport Canada - Transportation Development Centre

The Transportation Development Centre (TDC) is the Federal Government's lead agency for the application of science and technology to improve transportation in this country. Formed in 1970, it is located in Montreal, the traditional headquarters for Canada's major transportation operators and equipment manufacturers.

TDC's role is to identify, promote and manage the application of science and technology towards a more efficient and effective Canadian transportation system. TDC's specific objectives are:

- (i) To provide components of Transport Canada with specific data, research, and demonstration projects to assist them in their operational, regulatory, policy planning and evaluation functions.
- (ii) To undertake exploratory research and development in transportation technology and systems that are high risk, long range and national in scope.

Energy-related projects are itemized by transportation type. In most cases the project title, R&D contractor, and TDC project officer are all the information provided. TDC publishes an excellent Project Directory on an annual basis and the reader is advised to consult the 1982 directory for descriptions of the projects listed below.

Rail

- (i) Cartier Railway Electrification study (Contractor - Quebec Cartier Mining Co. and Canadian Pacific Consulting Services Ltd., project officer - C.A. Versailles).
- (ii) B.C. Rail Electrification Study (Contractor - British Columbia Railway, project officer - C.A. Versailles).
- (iii) Energy Storage System for Railway Electrification (Contractor - SNC Inc., project officer - C.A. Versailles).
- (iv) A.C. Traction Motors for Locomotives (Industry, Trade and Commerce Canada, Brown Boveri Canada Ltd., Bombardier Inc. and CP Rail have negotiated a project for the testing of such a motor in a CP Rail locomotive, project officer - M. Audette).
- (v) Stirling Cycle Locomotive Engine (Contractor - University of Calgary, project officer - R.H. Dillon).
- (vi) Medium-Speed Diesel Combustion Research (Contractor - Bombardier Inc., project officer - R.H. Dillon).
- (vii) Shunter Locomotive Study (Contractor - Bombardier Inc., project officer - R.S. Nishizaki).
- (viii) Rail Car Insulation Standards (project officer - B. Marshall).
- (ix) Rail Car Power Management (project officer - B. Marshall).

Federal Government - Transport Canada - TDC (continued)

Road

- (i) Articulated Intercity Bus Testing and Evaluation (Contractor - Voyageur Inc., project officer - T. Smith).
- (ii) Intercity Bus Fuel Efficiency. Eight different buses supplied by Voyageur tested (Contractor - TES Limited, project officer - B. Marshall).
- (iii) Compliant Air Bearings to Assist Intermodal Cargo Transfer. The objective of this project is to evaluate the suitability of the Sail Rail technique for the intermodal transfer of cargo on pallets at a freight terminal. (Contractor - University of Toronto - Institute for Aerospace Studies, project officer - J. Laframboise).
- (iv) Non-Petroleum Energy Sources for Urban Transit (Contractor - IBI Group, project officer - T. Smith).
- (v) Signal System Optimization Package Program Enhancements (Contractor - DeLCan Ltd., project officer - S. Corbeil).
- (vi) Development of Propane-Fueled Vehicles (Contractor - Chrysler Canada Ltd., project officer - J.H. Morgan).
- (vi) Optimization of Propane Engines (Contractor - Chrysler Canada Ltd, project officer - J.H. Morgan).
- (vii) Propane/Diesel Engine Development (Contractor - Space Fuel Gas Products Ltd., project officer - J.H. Morgan).
- (viii) Hybrid Road Vehicle Development. Design, construction and evaluation of two hybrid gasoline/electric vehicles, one in a series drive configuration and the other in a parallel configuration (Contractor - Marathon Electric Vehicle Inc., project officer - J.H. Morgan).
- (ix) Diesel/Flywheel Hybrid Drive Train (Contractor - UTDC, project officer - C.A. Versailles).
- (x) DISC Engine Feasibility Study (Contractors - SNC Inc., Ontario Research Foundation, Purolator Canada, Texaco Research Inc., project officer - J.H. Morgan).
- (xi) Nickel-Zinc Batteries for Road Vehicle Propulsion (Contractor - Cominco Ltd., project officer - J.H. Morgan).
- (xii) Vehicle Battery Research and Development in Canada. Analyses of the current status of vehicle battery technology in Canada so as to identify possible areas for federal government support for research and development (Contractor - R.F. Webb Corporation Ltd., project officer - J.H. Morgan).
- (xiii) Inflatable Fairings on Trucks (project officer - B. Marshall).

Federal Government - Transport Canada - TDC (continued)

Air

- (i) Mixed Flow Turbine Study (Contractor - Pratt & Whitney Aircraft of Canada Ltd., project officer - D. Hanchet).
- (ii) Fuel Efficient STOL Aircraft (Contractor - de Havilland Aircraft of Canada Ltd., project officer - D. Hanchet).
- (iii) Small Transport Aircraft Fuel Efficiency (Contractor - Canadair Ltd., project officer - D. Hanchet).
- (iv) Augmentor Wing Cruise Performance Study (Contractor - de Havilland Aircraft of Canada Ltd., project officer - D. Hanchet).
- (v) Gas Turbine Ceramics Technology (Contractor - Pratt & Whitney of Canada Ltd., project officer - D. Hanchet).

Funding

In the order of \$1.7 million was allocated by the Panel Energy R&D (PERD) to the above list of projects during the 1982/83 fiscal year. Additional Transport Canada funds and contractor contributions are also involved in many of the projects and hence the total funding in the above projects is considerably in excess of \$1.7 million.

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Note also the project officers listed for individual projects.

Publications

TDC publishes all of its research; each project is described in a technical report. TDC's Project Directory is an annual publication which gives descriptions of each active project and also gives a complete listing of technical report titles and their availability; interested individuals should write TDC requesting a copy of the Project Directory.

Federal Government (continued)

Transport Canada - Road Safety Directorate

The Road Safety Branch has a program of research, development and evaluation to support the administration of the Motor Vehicle Fuel Consumption Standards Act (Bill C-107); areas of responsibility under the program are:

- (i) fleet fuel consumption data;
- (ii) the measurement, analysis and modelling of vehicle fuel consumption;
- (iii) assessment of fuel conservation technology;
- (iv) assessment of the technology for automotive use of alternative fuels and energy storage systems;
- (v) development of regulatory techniques.

Projects

The current list of projects is as follows:

- (i) Monitor and Assess Trends in Vehicle Fuel consumption. This work includes the passenger car survey published by Statistics Canada. Plans are being made to extend this survey to cover light trucks and vans.

Additions to the Statistics Canada for-hire truck survey and a new private commercial truck survey will result in complete fuel consumption data base for automobiles and trucks.

- (ii) Evaluation of Low Temperature Fuel Economy. Four technologies for improving fuel economy during cold weather start-up were tested. An executive summary of the work is being prepared; Chrysler Canada was the contractor.
- (iii) On-Board Auto/Truck Fuel Data Acquisition and Analysis. Included under this general heading are the following specific items:
 - comparison of lab-cycle with on-road performance
 - determination of the effects of tire pressure on fuel consumption
 - development of models and analysis techniques for relating on-road data and laboratory results.
- (iv) Truck Rolling Resistance Measurement System (Davis Engineering is contractor).
- (v) Vehicle Safety Standard for LPG & CNG
- (vi) Safety Standards and Regulation for Alcohol Fuelled Engines
- (vii) Methanol Blend in Current Autos (Province of Ontario - MTC)

Federal Government - Transport Canada - Road Safety Directorate (continued)

- (viii) Methanol/Gasoline Fuel Emulsifier (Ontario Research Foundation)
- (ix) Low Temperature Performance of Alcohol Fuelled Autos.
- (x) Evaluation of Techniques to Improve Energy Efficient Driving Behaviour
- (xi) Energy Conservation Through Improved Traffic Operation Measures
- (xii) Commercial Vehicle Driver Training
- (xiv) Engine Efficiency Improvements through Fan and Accessory Decoupling Clutch (Fram Canada Ltd.)

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Transport Canada - Energy Planning Directorate

The Energy Planning Directorate was established in December 1981 for a two-to-three year term to undertake the task of developing a long-term strategic energy plan for Transport Canada. Projects have been initiated which support the development of such a plan.

Projects

- (i) Assessment of Energy Conservation Options. The objective of this project is to identify all longer term options in the area of energy conservation. (Parviainen & Associates)
- (ii) Impact of Government Policies Upon Transportation Energy Efficiency. Existing legislative, regulatory and fiscal measures, at all levels of government are being reviewed to identify which constrain or enhance the effective use of transportation energy. (R.K. House and Associates)
- (iii) Investigation of Market Potential for CNG as Transportation Fuel. (Canadian Resourcecon)
- (iv) Investigation of Propane as an Alternative Motor Vehicle Fuel in Canada. (R.F. Webb Corporation Ltd.)
- (iv) Investigation of the Potential Use of Alcohols as Components of Transportation Fuel Supply. (Middleton and Associates)

Federal Government - Transport Canada - Energy Planning Directorate
(continued)

- (v) Comparative Assessment of Conventional and Alternative Transportation Fuels. This study, planned for the summer of 1983, will synthesize information from previous studies of propane, CNG and alcohols with new information developed on conventional fuels and attempt to place all candidate fuels on a common basis for economic comparison purposes.
- (vi) Data Base Development for Heavy Vehicle Fuel Consumption. On-board monitoring devices to be installed on two heavy haul tractors in Saskatchewan (Transportation Agency of Saskatchewan). Also, historical data from several trucking firms in Winnipeg area analyzed to establish empirical relationship between fuel consumption and G.V.W. of heavy vehicles. (Alan Clayton - University of Manitoba)
- (vii) Inventory of Fuel/Engine Testing Facilities. (RTAC)

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Publications

Reports are currently available on propane markets and the inventory of fuel/engine testing facilities. Other projects are scheduled for completion in 1983.

Transport Canada - Economic Analysis Directorate

Responsibility for energy demand forecasts rests with this directorate. Studies undertaken include the following:

- (i) Intercity passenger and freight energy studies.
- (ii) Survey methodology development - private trucking and for-hire trucking.

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Canadian Transport Commission

Background

The Research Branch of the Canadian Transport Commission (CTC) is a major transportation research group within the Federal Government. CTC specializes in economic type research.

Projects

The Canadian Transportation Commission does not undertake energy-related transportation R&D projects. Energy-related topics are handled by the Research and Development Directorate, the Energy Planning Directorate and the Economic Analysis Directorate of Transport Canada.

Energy, Mines and Resources - Transportation Energy Division

The Transportation Energy Division, Conservation and Non-Petroleum Sector is the focal group within EMR for energy-related transportation activities. Within the Transportation Energy Division, the following areas of transportation fuel utilization are covered - vehicle energy consumption, transportation systems, fuels policy, automotive technology, alternative fuels and information and liaison. The Transportation Energy Division has the main responsibility for Panel on Energy R&D's Task 5.0, New Liquid Fuels; in addition, policy issues with respect to the supply of alternative transportation fuels and transportation fuels utilization are handled by this group. (Director - Dr. A.C. Taylor and Research Coordinator - Roy Sage)

Projects

- (i) Data base studies. A continuing program exists to improve the data base with respect to energy use in the transportation sector. An improved data base is important for regulation, policy development and program evaluation. Specific activities include:
 - analysis of government motor vehicle fleet by vehicle type, season, and region;
 - vehicle survival rates and a model to estimate vehicle population (to 1995);
 - data base development using Statistics Canada vehicle registration files;
 - review of estimates of truck fuel consumption in Canada;
 - comparison of on-road fuel consumption trends vis-a-vis EPA ratings. (Peter Reilly-Roe)
- (ii) Pre-emergency measures. Study of demand restraint measures that might be used in the event of a modest shortfall in gasoline. Impact of measures on mobility in rural areas included in study (Manitoba). EMR is cooperating with Interprovincial Advisory Committee on Energy (IPACE) on this study. (H. Mokhar)
- (iii) Energy Management in the Canadian Airline Industry. (See Air Transport Association of Canada listing). (H. Mokhar)
- (iv) Truck Outreach Program. Study on making energy conservation information available to trucking industry is in progress. Manitoba is test province. (H. Mokhar)

Energy, Mines and Resources - Transportation Energy Division (continued)

- (v) Evaluation Fuel Engine Systems. (G.B. Maund)
- (vi) Studies of Fuel Conservation by Mode. (G.B. Maund)
- (vii) Urban and Regional Transportation R&D. (H. Mokhar)
- (vii) Phase-down of lead content in gasoline. (G. Taylor)
- (viii) CNG Demonstration Programs. Two CNG fleets - Black Top Cabs (Vancouver) and Inland Natural Gas (Kamloops) - are being monitored (B. James).
- (ix) Propane Grant Program. EMR offers a taxable grant for propane conversions. (J. Gibson)
- (x) CNG Grant Program. EMR offers a \$500 grant for a CNG conversion and up to \$50,000 for CNG compression equipment at a retail station. (R. Sage)
- (xi) CNG Centre at B.C. Research (and University of B.C. - Department of Mechanical Engineering). EMR is providing the funding for the development of a CNG centre of excellence at B.C. Research. (B. James)

Contact Persons

Dr. A.C. Taylor - Director
Mr. Roy Sage - Research Coordinator
Mr. Peter Reilly-Roe - Chief, Information and Liaison
Mr. Ron Solman - Chief, Vehicle Energy Program
Mr. Han Mokhar - Chief, Transportation Systems
Mr. Geoff Maund - Chief, Automotive Technology
Mr. Bernie James - Chief, Alternative Fuels

Transportation Energy Division
Conservation and Renewable Energy Branch
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Publications

A list of publications available from the Transportation Energy Division can be obtained from Mr. Peter Reilly-Roe.

National Research Council - Division of Mechanical Engineering

Energy-related transportation research is performed by the Fuels and Lubricants Laboratory (Dr. R.B. Whyte) and by the Engine Laboratory (H.S. Fowler).

Projects

- (i) Diesel fuels. Diesel fuel quality is expected to deteriorate in the future as low cetane material from oil sands synthetic crude and from heating oil displaced by natural gas is more abundant. NRC has taken two approaches to the development of information on the performance of diesel engines on a lower cetane fuels. First, NRC has available roughly 100,000 gallons of diesel fuel made from conventional crude, tar sands synthetic crude and hydrofined cat-cracked (heating oil) stocks with a cetane number of 35 and a somewhat higher distillation end-point than normal diesel fuel. This fuel will be made available to engine manufacturers, independent investigators, fleet operators, etc. to carry out combustion studies, laboratory engine operation and durability tests followed perhaps by field testing. Second, NRC has made initial tests on a Detroit Diesel 3-71 engine in their own laboratory using fuels with cetane numbers of 35 and 30. A Ricardo Hydra is being purchased and should be available for a variety of work on fuels, combustion, and combustion chamber design in the near future.
- (ii) Vehicular Engine Cooling Dynamics. Side intakes for cooling air have been shown to be as effective as ram air systems for engine cooling. Wind tunnel tests are continuing on cars (in conjunction with Fram Canada) and in trucks (in collaboration with International Harvester) to optimize the application to actual vehicles.
- (iii) Hydraulic/Diesel Bus. A project has been proposed to build a prototype city bus with diesel engine/hydraulic drive with an accumulator to recover braking energy. Initial experiments with a small car using this system shows that city bus fuel consumption could be reduced by one third whilst there is also a large saving in brake maintenance.
- (iv) Testing of Automotive Add-on Devices. NRC will test fuel and lubricant additives, carburetion add-on devices, etc. which claim to improve fuel economy.
- (v) General Study. NRC have some projects of a more general nature on combustion of fuel sprays, stratified charge combustion, alternative fuels, automotive retrofits, etc., which may, on further development have some applications in road transportation.

National Research Council - Division of Mechanical Engineering (continued)

Contact Persons

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National Research Council - Division of Energy Research and Development

NRC's Division of Energy Research and Development coordinates the Panel on Energy R&D's program 5.6, Hydrogen and Energy Storage; Dr. J.B. Taylor is the coordinator. The two sub-programs of interest from the transportation point of view are 5.6.2, Hydrogen Utilization, which covers the fields of storage, transmission, safety and end-use of hydrogen, and 5.6.3., Energy Storage, which covers the use of electrical energy in transportation including battery technology and electric vehicles.

Projects

- (i) Hydrogen utilization. The storage of hydrogen is being assessed experimentally and analytically on both large and small scales. A wide range of technologies is under active review including development of systems in which hydrogen is stored and transported as more tractable liquids such as ammonia and methanol.

Engineering and fundamental work is now being started on both internal combustion and gas turbine engines. This work is expected to lead to the definition of a hydrogen specific engine.

Fuel cells have mobile and stationary applications. Included in the program are component development and applications work. Some joint activities are anticipated with the newly formed Ontario Institute for Hydrogen Systems. (University of Toronto)

National Research Council - Division of Energy Research and Development
(continued)

- (ii) Electrical Energy Storage. The existing program on batteries has concentrated on one type (Li/FeS) which is now progressing to the early stages of commercial development. A major effort is now in place to solve the manufacturing technology problems. Vehicle systems are being assessed, analysed and developed. Since batteries have lower power densities than conventional IC engines, consideration is being given to hybrid drives with either small IC engines or with flywheels.

Contact Person

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Department of National Defence

Background

The broad transportation objectives of the Department of National Defence (DND) is that Canada's Armed Forces should be able to operate in the future unaffected by the quantity and quality of the fuels available.

Over 90 percent of DND's annual fuel requirement is for middle distillate fuels - diesel oil and aircraft turbo fuel. DND's R&D priorities are directly related to this consumption pattern, and focus on future problems that may exist with middle distillate fuels supply as the mix of crude oils available to Canadian refineries changes in the future.

Projects

- (i) Characterization of gas turbine engine combustion with oil sands-based fuels - three year program at University of Laval.
- (ii) High speed diesel combustion performance of engines with degraded diesel fuel. Computer modelling and comparison with engine on a test bed - three year program at the University of Ottawa.
- (iii) Limit to which medium speeds diesels can use degraded diesel fuels - five different fuels - three year program by Bombardier and the Naval Engineering Test Establishment in Montreal.
- (iv) Improved cold starting with plasma plugs in diesel engines -University of Alberta (Edmonton).
- (v) DND participates with ITC and the U.S. Air Force in gas turbine combustion research; ten different fuel types are being tested for a variety of engine operating parameters. Research is performed by Pratt & Whitney in Montreal.
- (vi) DND has two "in-house" laboratory facilities. The Defence Research Establishment Ottawa (DREO) has a small engine laboratory, with two single cylinder diesel engines and two engine test cells under construction. A coherent raman stokes spectrometer (CARS) is part of the laboratory's equipment; this is a laser device that measures the concentration of the constituents of combustion flames. The Royal Military College, Kingston, has small diesel engine research capability (single cylinder Ricardo engine), and research projects include the testing of off-specification fuels and other alternative transport fuels, and low temperature fuel injection in diesels and gas turbines.

Department of National Defence (continued)

- (vii) DND will convert approximately 4,000 vehicles to propane over the next five years at 32 bases across Canada. Conversion will be accomplished by replacing retiring gasoline powered vehicles with production line propane vehicles. No combat vehicles will be converted to propane.

Funding

DND receives some NEP funds (\$700,000/year) and allocates approximately \$600,000/year of DND funds to their in-house activities. The joint program with ITC and the U.S. Air Force amounts to \$800,000 per annum.

Contact Persons

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Propane Conversions:

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Industry, Trade and Commerce

The Department of Industry, Trade and Commerce (ITC) does not initiate research and development projects. ITC does, however, administer a number of grant programs that can be a source of funds for Canadian firms undertaking R&D activities. The two main programs that may be of interest to transportation and energy researchers are Industrial Energy Research and Development Program (IERD) and Enterprise Development Program (EDP).

Projects

- (i) IERD. The Industrial Energy Research and Development program, established in 1977, is aimed at encouraging and assisting Canadian industry to undertake research and development of new and improved products, processes and equipment that will reduce energy consumption. The IERD contribution is up to 50 percent of the total estimated cost of an approved project. To date, a limited number of transport sector projects have received IERD funds.
- (ii) EDP. The objective of the Enterprise Development Program is to help the growth of the manufacturing and processing sectors of the Canadian economy by providing assistance to selected firms to make them more viable and internationally competitive.

The thrust of the program is to foster innovation in the design and development of new or improved products or processes and to assist adjustment to changing competitive circumstances.

EDP provides support to eligible firms by:

- Sharing project costs. For the typical shared-cost project, the EDP can make a contribution of up to 75 percent of the eligible costs.
- Providing insurance on a term loan to finance the project. Loan insurance can be provided for 90 percent of a term from conventional lenders for a 1 percent annual fee.

Energy-related transportation projects have been supported by EDP grant, e.g., Prevost (articulated bus), Western Star (aerodynamic cab design), Canadian Methanol Canadian (fuel specification testing), KHD Canada (diesel engine development).

Industry, Trade and Commerce (continued)

Contact Persons

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British Columbia Government

Background

Three ministries were contacted with respect to their energy and transportation activities:

- (i) Energy, Mines and Petroleum Resources - Conservation and Renewable Energy Branch.
- (ii) Universities, Science and Communications.
- (iii) Transportation and Highways.

CNG as an alternative transportation fuel has been a primary topic of investigation in British Columbia; this activity was originally promoted by the Ministry of Universities, Science and Communications and is now handled by the Energy Development Agency (an inter-ministry committee). The Conservation and Renewable Energy Branch of the Dept. of Mines and Petroleum Resources has completed some transportation related conservation and alternate fuels work; most of this has been funded under the Federal/B.C. Conservation and Renewable Energy Development Agreement (CREDA). Transportation and Highways energy-related transportation projects are confined to operating tests on their own departmental vehicles.

Energy, Mines and Petroleum Resources - Conservation and Renewable Energy Branch

The Conservation and Renewable Energy Branch has undertaken both energy conservation and alternate fuels projects.

Projects

- (i) Alternate Fuels for Automotive Vehicles in British Columbia. This study assessed the technology, economics, and market potential of propane, natural gas (CNG, LNG) and alcohol fuels as automotive fuels. Contractor was Canadian Resourcecon Limited.
- (ii) Alcohol Fuel Production from Wood Biomass. This study is an assessment of the technical and economic viability of producing methanol or ethanol fuels in B.C. from forest biomass. The transportation fuel market was felt to be the logical market for such production. Contractor was Canadian Resourcecon Limited, McDaniels Research Ltd. and B.H. Levelton and Associates Limited.
- (iii) The Branch participated with EMR in Operation Tune-up. The B.C. Automobile Association handled the technical aspects setting up in public locations, testing cars and providing advice on fuel efficiency driving habits, etc.

British Columbia Government - Energy, Mines and Petroleum Resources -
Conservation and Renewable Energy Branch (continued)

- (iv) Future activities. The Branch is interested in undertaking projects on the following topics: Teleride, commercial vehicle fleet management strategies (training sessions, demonstration, etc.), computerized traffic control, a Truck Save program for the forestry sector, and driver training. Availability of funds will play an important role in which projects proceed.

Contact Person

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Universities, Science and Communications

The Ministry initiated the interest in compressed natural gas (CNG) as a vehicle fuel in British Columbia. The responsibility for CNG has now been passed on to the Energy Development Agency (an inter-ministrial committee) and to B.C. Research and U.B.C. - Mechanical Engineering Department.

Projects

- (i) Methane: Fuel for the Future. Sponsored international conference on CNG; proceedings of conference published under the title Methane: Fuel for the Future, edited by Patrick McGeer and Enoch Durkin (Plenum Press: New York, 1982).
- (ii) CNG Conversion Training: A CNG conversion training course has been set up at the Pacific Vocational Institute.
- (iii) CNG Promotion. Funded through the Energy Development Agency, a CNG promotion campaign is being developed by a private company, Methane Energy Development.

Contact Persons

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Ministry of Universities, Science and Communications
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British Columbia Government - Universities, Science and Communications
(continued)

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Transportation and Highways

A number of actions with respect to the Ministry's vehicle fuel have been taken: switching to diesel engine in light trucks, some conversion of vehicles to propane, and testing of diesel/CNG.

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B.C. Research

Background

B.C. Research is a technological research institute conducting research, development and other technical work in the fields of applied biology, applied chemistry, engineering-physics and management services. B.C. Research is supported by a grant from the B.C. Government (approximately 7 percent of revenues is from their provincial grant); however, the bulk of revenues are from contract research for industry and government clients.

B.C. Research has a staff of approximately 170 people; present facilities are located adjacent to the University of British Columbia and include chemical, biological and engineering laboratories.

Projects

The interest in compressed natural gas (CNG) as a vehicle fuel in British Columbia and Canada has led B.C. Research to set up a Natural Gas Fuel Group to both coordinate and perform CNG research and development. The Federal Government (EMR) is supporting the development of a CNG centre at B.C. Research; that support included an initial \$400,000 contract to B.C. Research to develop a CNG testing facility, to carry out an initial CNG testing program and to develop a long term program of CNG research and development.

B.C. Research has drawn up the longer term CNG plan and expect to sign a contract with EMR in June, 1983 for \$1.6 million over 21 months; B.C. Research will be identified as the prime contractor in a CNG R&D program. The elements of the CNG program and the expected level of expenditure are as follows:

- (i) Fundamental combustion research. A program of basic combustion research with respect to natural gas is proposed. The Alternative Fuels Laboratory at the University of B.C. is the likely performer of this work; \$600,000 has been allocated to this area of research.
- (ii) CNG equipment testing. B.C. Research will evaluate commercial CNG equipment; some equipment development work may also be carried out at B.C. Research. Approximately \$500,000 is earmarked for B.C. Research's internal equipment testing activities.
- (iii) CNG equipment development. B.C. Research will channel funds to CNG equipment manufacturers for CNG equipment development. Approximately \$500,000 will be made available to CNG equipment manufacturers through B.C. Research.

B.C. Research (continued)

As well as the technical R&D on CNG, B.C. Research will act as a Canadian information clearing organization for CNG.

Contact Person

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Alberta Government

Background

Three departments were contacted within the Alberta government.

- (i) Transportation - Research and Development Branch. This branch has a major responsibility for the transportation R&D function particularly with respect to highways.
- (ii) Department of Energy and Natural Resources - Energy Conservation Branch. The major responsibility of this branch is energy conservation including the transportation sector.
- (iii) Department of Economic Development -Transportation Services. The major interest of this department is in the role of transportation systems in economic development; consequently they have an interest in intermodal transportation issues including truck freight and rail passenger and freight services.

Department of Transportation - Research and Development Branch

This branch manages the research and development activities of Alberta Transportation. Only a limited number of their projects, however, can be classified as energy related.

Projects

- (i) Vehicle Retrofit (PED & CONDENSATOR). This project consists of a field evaluation of two fuel economy devices - the PED and the CONDENSATOR - in a number of departmental trucks. A final report has been completed on the performance of PED. A technical memorandum will be issued on the performance of the CONDENSATOR.
- (ii) Neo-ken Improved Electric Motor. This project is to develop a prototype electric motor in the range of 30-40 HP and demonstrate its capabilities in late model vehicle. Two working models of the motor in the range of 2-5 HP have been bench tested. A 30 HP motor is nearing completion and will be ready for bench testing. The federal Transport Development Centre has agreed to fund the cost of testing the motor under their electrical vehicle program. This will be followed by installation in a van and more testing in early 1983.

Alberta Government - Dept. of Transportation - Research and Development
Branch (continued)

- (iii) Propane Vehicle Evaluation. Six departmental trucks were converted to exclusive propane operation. All vehicles have been performing relatively satisfactorily to date. There has been no serious adverse operator acceptance. Some fuel consumption figures are available and are being analyzed.
- (iv) Recycling of Asphalt Pavement Materials in Alberta. This project involved a review and investigation of the available technology for recycling of hot mix pavements in the U.S.A. and Canada.

Funding

The projects listed for the R&D Branch have received modest funding levels.

Contact Person

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Department of Energy & Natural Resources

The focus of the Department's research and development efforts with respect to transportation fuels is on the production of synthetic fuels from coal and oil sands. Only a minor amount of effort goes in research on fuel utilization.

The Energy Conservation Branch operates information and public awareness programs. Studies and research on energy related transportation issues are not numerous.

Projects

Fleet market propane transportation study. This study was undertaken in 1980 by a consultant - IBI Associates - and indicated possible propane market penetration in Alberta.

Funding

Funds are available for research in Alberta through the Canada/Alberta agreement on energy R&D. Most of this funding, however, has been allocated to fuel production issues, in particular the study of coal.

Alberta Government - Dept. of Energy & Natural Resources (continued)

Contact Person

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Department of Economic Development - Transportation Services

This department is interested in the role of efficient transportation systems related to economic development; consequently, a concern exists with respect to transportation issues. No projects have been undertaken to date, however, this department would like to organize a western Canada task force on energy and transportation to explore the issues that exist with respect to energy related transportation matters. A meeting for this task force is proposed for the summer of 1983. The outcome this meeting is a potential study of the transportation and energy issues relevant to the four western provinces.

Contact Persons

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Alberta Research Council

Background

The Alberta Research Council, established in 1921, is a Crown corporation dedicated to promoting responsible economic development in Alberta through science and technology. A major focus of the Council is on expanding Alberta's primary fuel resources through research on oil sands and heavy oils and on coal.

Projects

The Council is not engaged in R&D related to the utilization of transportation fuels. The Council does however maintain a fuels testing laboratory and is the primary location in Western Canada for the testing and quality control monitoring of transportation fuels.

Contact Person

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Saskatchewan Government

Background

Contacts were made with the Department of Highways and Transportation, the Saskatchewan Power Corporation and the Transportation Agency of Saskatchewan.

The Department of Highways and Transportation has undertaken an internal program of energy conservation as part of the provincial Target 10% program on energy conservation. No formal research projects have been undertaken by Highways and Transportation.

The Department of Mineral Resources was responsible for provincial energy conservation programs (Office of Energy Conservation); however, with the recent change of government in Saskatchewan, the Office of Energy Conservation has been disbanded and responsibility for energy conservation programs has been transferred to the Saskatchewan Power Corporation.

The Transportation Agency is responsible for bulk commodity transportation policy and has an interest in the fuel efficiency of tractor trailer combinations.

Highways and Transportation

Since the inception of the Department's internal energy conservation program several programs have been implemented to conserve energy.

Projects

- (i) Diesel powered units. Since the early 1970's, the department has been purchasing diesel powered truck units, and in 1979 several small diesel powered trucks were purchased. These have been found to be significantly more fuel efficient than comparable gasoline powered units.
- (ii) Propane vehicles. Eight units have been converted from gas to propane and four to a fuel system which will allow the use of either gasoline or propane to help evaluate energy savings.
- (iii) Recycling hydraulic oil. The recycling of hydraulic oil is a new innovation involving filtering out all impurities. The oil can then be returned to the hydraulic systems of the department equipment.
- (iv) Adding used lubricating oils to diesel fuel. Under the oil-recycling program the department is recycling used crank-case oil to be blended with diesel fuel and used as motive fuel. Filtering equipment is used to eliminate impurities from the motor lubricating oil. Up to 10% of this filtered lube oil can be added to diesel fuel without the manufacturer's warranty being affected.

Saskatchewan Government - Highways and Transportation (continued)

- (v) Mobile communications equipment. The Department's new communication system with radio-telephone interface is also saving fuel dollars by reducing travel required to get to a telephone for long distance communications.
- (vi) Driver training. Driver training program discusses the impact of operator habits, motor idling, tire inflation, gear selection, speed, and mechanical maintenance on vehicle efficiency.
- (vii) CNG vehicles. Vehicles are being tested on CNG.
- (viii) Other areas. Other areas the department has been involved in for many years that have contributed to energy saving, are highway design and construction, the use of materials such as ground rubber and sulphur in pavement; pavement recycling; increases in allowable vehicle weights and standards such as maximum grades, minimum radius of curvature, plus 4-lane highways.

Contact Persons

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Saskatchewan Power Corporation (SPC)

In addition to electricity distribution, SPC distributes natural gas throughout the province. SPC has been given responsibility for investigating the use of CNG in the province.

Saskatchewan Government - Saskatchewan Power Corporation (continued)

Projects

- (i) Forty vehicles currently operate on propane. SPC now favours CNG and has 8 vehicles on CNG with 20 more to follow shortly.
- (ii) SPC will likely test dual CNG/diesel fuel in a stationary diesel at their research centre. SPC has a diesel which has been running off a wood derived gas and this engine is a candidate for testing.
- (iii) SPC is interested in controlled testing of gasoline and CNG in order to establish the energy use equivalency between the two fuels.

Contact Person

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Transportation Agency of Saskatchewan

The Transportation Agency is responsible for bulk commodity movement policy; the Road Transportation Branch has as a primary objective the improved efficiency of road transport. In support of this objective, the Agency will do some on-board fuel monitoring in the 1983/1984 year (with financial assistance from Transport Canada) on two tractor units. A number of tractor-trailer combinations and routes will be tested in order to establish the relationship between fuel consumption and vehicle weights and configurations.

Contact Person

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Saskatchewan Research Council

The Saskatchewan Research Council (SRC) provides scientific and engineering assistance to industrial and government clients. SRC is supported by a grant from the provincial government; roughly 1/3 of SRC revenues come from this grant.

SRC has a staff of over 230 people and extensive research and laboratory facilities. SRC energy-related transportation research is in the area of alternative fuels produced from biomass and slurry pipeline transportation.

Projects

- (i) Alternate fuels from biomass. SRC is studying fuels derived from four major sources:
 - whole plant oil crops (milkweed primary candidate)
 - vegetable oil crops (most of the work to date has been on canola oil)
 - forestry biomass
 - agricultural crops and crop residues
(emphasis is on forage crops, both conventional forage crops and those that might be grown on saline soils)
- (ii) Slurry pipelines. SRC is continuing research into the hydraulic transportation of coal and other solids. SRC's slurry pipeline facility has international status as a centre for slurry transportation studies. Recent projects include the investigation of the transport of coarse coal in water and the disposal of oil sands tailings via pipelines.

Contact Person

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Publications

SRC publishes their research. Any requests for information should be directed to the SRC Information Centre.

Manitoba Government

Background

Two departments were contacted and questioned with respect to their energy-related transportation activities:

- (i) Energy and Mines, and
- (ii) Highways and Transportation

These two departments work closely in developing transportation projects; much of the funding comes from Federal/Manitoba Conservation and Renewable Energy Demonstration Agreement (CREDA) administered by Energy and Mines. Highways and Transportation has a modest Transportation Energy Management Program (TEMP) modelled on Ontario's program. Highways and Transportation has generated a number of interesting projects.

Energy and Mines

Projects

- (i) Gasohol and propane fleet test. This test was designed to evaluate the relative merits of propane and gasohol for commercial fleet vehicles under different climatic and load conditions. Under the two-year test, 75 vehicles ranging from cars and station wagons to vans and heavier trucks were being tested - 25 powered by propane, 25 powered by gasohol, and 25 control vehicles by gasoline. Manitoba Telephone System vehicles were used for the test and the Manitoba Research Council was responsible for monitoring and producing the detailed analysis (\$360,000 - CREDA project).
- (ii) Methanol Vehicle Fuel Test. Study will test and demonstrate the use of methanol as a vehicle fuel under Manitoba climatic conditions. Field tests will be conducted on three fleets of 25 vehicles each. Two fuel types are proposed: a 3% blend with gasoline and "neat" methanol with low temperature starting additives. Two of the fleets will use methanol-based fuels, while the control will use standard unleaded gasoline. This project is just beginning; Manitoba Research will manage the project (\$386,000 - CREDA project).
- (iii) Winnipeg Transit - Feasibility of Conversion to Non-Petroleum Power Sources. Paper study investigating the potential of alternative fuels such as methanol, propane, natural gas, hydrogen and electricity for the Winnipeg Transit System. Although the study recommended trolley (electric energy) bus, no action has been taken due to the uncertain outlook for fuel prices. The province is interested in a transit demonstration project that would test trolleys with off-line capability. Manitoba Research Council and Flyer Industries will be involved if funding can be secured. An ultimate outcome could be a rubber tired surface transit demonstration facility/institute including a test bed facility (\$150,000 - CREDA project).

Manitoba Government - Energy and Mines (continued)

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Publications

Reports are available for the Winnipeg Transit and Gasohol and Propane Fleet Test.

Highways and Transportation

The Department of Highways and Transportation has a Transportation Energy Management Program (TEMP) with the following goals: to conserve energy, to reduce miles driven and to make more efficient use of fuels. This program does not have a large budget (about \$60,000/annum) and the basic technique is to use other source of funds (e.g., CREDA) wherever possible.

Projects

- (i) Vanpooling. A five phase demonstration project is underway. The five phases are: promotional information packages distribution, educational seminars, feasibility studies, implementation, evaluation.
- (ii) Route Optimization. Three cases are being studied - an urban route (Western Groceries Ltd.), a rural route (Milk Marketing Board) and a school bus route. From the information obtained during the evaluation stage, route optimization recommendations will be formulated. As a follow-on to this work, the University of Montreal has a computer program that can represent networks and solve for a best route. A program to make this type of facility available to the commercial fleet sector is contemplated.

Manitoba Government - Highways and Transportation (continued)

- (iii) Drive-save and Truck-save. Driver education programs are offered (Drive-save for high schools).
- (iv) Federal Truck Outreach Study. This study will focus on Manitoba and the smaller more rural segment of the trucking industry.
- (v) Future Activities. A proposal has been developed for the study of anti-idling and speed control devices with the Manitoba Trucking Association. Other future projects contemplated include:
 - a study of fuel conservation incentives (commercial fleets) including an analysis of which incentives are effective in which circumstances.
 - develop standard fuel conservation modules for driver refresher courses.
 - study of driver reaction to instantaneous fuel consumption readout devices.
 - demonstration of rail/bus in remote areas of Northern Manitoba.
 - propane information service.

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Industrial Technology Centre/Manitoba Research Council

Background

The Industrial Technology Centre of the Manitoba Research Council is jointly funded by the Canada Department of Regional Economic Expansion and Manitoba Department of Economic Development and Tourism under the Enterprise Manitoba Agreement. The objectives of the Centre are to provide scientific and technical services to Manitoba industry, to stimulate the application of new technology to Manitoba industry, to translate evolving technology into new manufacturing opportunities and to enhance the appeal of Manitoba as an industrial location.

The Industrial Technology Centre facilities opened in March 1979. The Centre has a staff of approximately 40. The Centre provides free office space for the Biomass Energy Institute Inc., a non-profit organization which serves as an information centre for alternate energy. The location of this group within the Industrial Technology Centre enables joint use of library and information facilities and cooperative work on priority alternate energy studies.

Projects

The Industrial Technology Centre has a number of alternate fuels projects. The Centre has the use of the K-Cycle engine test facilities.

- (i) Gasohol and Propane Fleet Test. (see Government of Manitoba listing).
- (ii) Methanol Vehicle Fuel Test. (See Government of Manitoba listing).
- (iii) Propane low temperature starting trials.
- (iv) Worldwide survey of corrosion vis-a-vis methanol fuel.
- (v) Biomass fuels. The Industrial Technology Centre is active in this field - developing tests and testing sugars for Canertech, testing grains and other crops for Mohawk, etc.
- (vi) Future activity. The Centre anticipates testing Proformax (synthetic lubricant) for NRC, fundamental engine studies on ammonia for NRC and diesel/propane fueling for stationary engines with ICG.

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Ontario Government

Background

Contact was made with the Ministry of Transportation and Communication (MTC) and with the Ministry of Energy. Energy-related transportation R&D is a well organized and coordinated activity between these two ministries.

Recognizing Ontario's dependence on scarce and increasing expensive crude oil and the importance of refined petroleum products to the transport sector, Ontario established the Transportation Energy Management Program (TEMP) in 1977. The primary focus of TEMP is on the 4.8 million cars, trucks and buses operated in Ontario since they account for the lions share of the oil products consumed by the transportation sector. TEMP is aimed at the achievement of four transportation energy goals established by the Ontario Government:

- (i) A 35% reduction in the fuel consumed per passenger kilometre in passenger transportation by 1995.
- (ii) A 20% reduction in the fuel consumed per tonne-kilometre in freight transportation by 1995.
- (iii) A 10% reduction in fuel used in the Ontario Government fleet by 1983.
- (iv) A 2% oil substitution through the use of alternative fuels by 1985 and 10% by 1995.

TEMP is a joint program involving MTC and the Ministry of Energy. The Ministry of Energy coordinates all of the energy R&D activities within the Ontario Government and in this role provides the funds for TEMP and, in consultation with the MTC, plans the TEMP program year by year. The Ministry of Transportation and Communication administers TEMP with the aid of 50-60 in-house staff. The Ministry of Energy provides advice to the Government on transportation energy conservation and alternate transportation fuels policies and undertakes a limited amount of research in support of this policy role.

It should be emphasized that the Ontario Government activities in energy and transportation are well organized, well funded and wide ranging in both the energy conservation and alternate fuels areas.

Ontario Government (continued)

Ministry of Transportation and Communications

MTC administers the Transportation Energy Management Program (TEMP). This program has existed since 1977; funding for TEMP has built up to a level of about \$2.3 million in 1982/83. Activities included in TEMP range from fundamental and applied technical research to promotion and marketing support for energy conservation programs (e.g., Drive Save).

TEMP has several modules which involve specific transportation user groups and the 1982/83 project list given below is organized by module. The list below is essentially the 1982/83 projects and hence is not a complete list of topic areas investigated under TEMP; some projects completed in the earlier years of TEMP may be of interest and readers are directed to the TEMP Quarterly Status Reports for descriptions of earlier TEMP projects.

Projects

(i) Municipal:

Transportation Energy Analysis Manual (TEAM)
Municipal Transportation Energy Advisory Committee
Computer Controlled Traffic Signal Demonstration
Alternative Work Schedules for Energy Conservation
Metro Toronto Area Transportation Energy Studies
Fleet Management Demonstration - Phase I & II
Booklets Based on TEAM Chapters
Municipal Driver Training Program

(ii) Drive Save:

Drive Save Communications Plan
Tune/Detune
Assessment of Auto Driver Feedback Devices
Community Group Component to Promote Tire Clinics
Improving the Fuel Economy of Automobile Fleets
Fuel Economy Program for High School Driver Education
Seasonal Outreach Campaign for the General Licensed Driver
Seminar Programs for Driving Instructors & Educators
Drive Save Newsletter
Drive Save Media Awareness
Drive Save Fuel Economy Contest
Community Sponsored Maintenance Clinics
Drive Save Evaluation of Road Driver Behaviour

(iii) TRIM (10 Percent Saving in Government Fleet Fuel Use):

Ontario Government Fleet Energy Management

Ontario Government - MTC (continued)

(iv) Share-a-Ride:

The Status of Worker Bus Operations in Ontario
Employer Sponsored Ridesharing Program
Carpool Matching for Government Employees

(v) Truck Save:

Ontario Truck Fuel Economy Advisory Program
Manual on Fuel Efficient Truck Specification
Energy Efficient Commercial Vehicle Driver Training Program
Reduction of Truck Idling
Truck Engine Temperature Control for Fuel Efficiency
Over-the-Road Fuel Economy Tests and Competition

(vi) Teleconferencing:

Private Sector Teleconferencing Publicity
Private Sector Teleconferencing Implementation
Teleconferencing Product Development
Ontario Government Teleconferencing Implementation
Survey of Teleconferencing Use in the Private Sector
Transportation/Communications Substitution

(vii) Data Analysis:

Transportation Energy Monitoring Reports
Transportation Energy Conservation Data Survey
Transportation and Energy Implications of the DRI Model

(viii) Alternative Fuels:

General

Alternative Fuels Program Marketing
Alternative Fuels Program Publicity
Engine Test Facility Assessment and Preliminary Design
Alternative Fuels Market Assessment

Hydrogen

Hydrogen Engine Testing and Development
I.C. Engine Performance Hydrogen/Carbon Monoxide Mixtures

Ontario Government - MTC (continued)

Propane

Drive Propane Demonstration
Promotion of Propane as an Alternative Fuel
Testing and Evaluation of Propane Conversion Equipment
Testing and Evaluation of Propane Conversion Equipment on
Large Displacement Truck Engine
Propane Fuel Utilization Program Design
Evaluation of Propane Conversion Systems on Vehicles
Propane Conversion Kit Evaluation - Ford 300 CID Engine
Government of Ontario Propane Vehicle Program

CNG

Development of a CNG/Propane Engine Configuration
Demonstration of CNG Utilization in Private Sector Fleets
Testing and Evaluation of CNG Conversion Kits on Engine Dyno
Compressed Natural Gas Utilization Program Design
Feasibility of Development of Advanced Storage Media for
CNG
Laboratory Tests on Absorbent Media for Storing CNG
Testing and Evaluation of CNG Conversion Kits on Vehicles

Methanol

Methanol Blends (M-10) Road Test with Government Vehicles
Straight Methanol Vehicle Evaluation
Private Sector Methanol Blends (M-10) Demonstration
Alcohol Blends Utilization in Diesel Engines Assessment and
Program Design
Alcohol Fuel Utilization Program Design

Contact Persons

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Ontario Government (continued)

Publications

Project documents and reports exist for many of the TEMP projects; contact Mr. R. Kidman for information on available documents. Note that TEMP has generated materials suitable for distribution to the general public in a number of areas, e.g., Drive Propane, Truck Save, etc.

TEMP produces Status Reports at regular intervals; these documents summarize all of the active TEMP projects and useful overview documents.

Ministry of Energy

The Ministry of Energy in support of their regulatory and policy functions undertake certain studies. The projects listed below illustrate the types of activities undertaken by the Ministry of Energy.

Projects

- (i) Changes required to regulations and legislation to allow resale (at retail) of natural gas as CNG.
- (ii) CNG safety regulations (with Ministry of Consumer and Corporate Relations).
- (iii) Work with municipalities on propane tank and dispensing facilities siting regulations.
- (iv) Alternative transportation review.
- (v) Review of LNG as a transit bus fuel.

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Ontario Energy Corporation

Background

The provincially-owned Ontario Energy Corporation was formed in 1974, and operates as a self-financing corporation under an independent board of directors. Objectives include enhancement of energy availability in Ontario and encouragement of the development of processes (physical equipment or operational strategies) to avoid wasteful use of energy. A number of investments have been made in transportation-related projects. Typically, investments are intended to carry apparently viable technology or concepts through a development stage for which alternative funding would be uncertain. Subsequently the proven business is sold and a return on the investment is realized.

Projects

Ontario Van Pool Organization Ltd. (John Kemp-Welsh)

Since April, 1980, with an investment of some \$400,000, 35 van pools have been established (organization and provision of vehicles). The 11 or 12 member pools pay fees estimated to cover operating costs, though opportunity pricing relative to alternative modes is also of interest. Average daily round trips are 150 km, and the longest about 270 km. The system appears to have reached a stage of proven viability for either single van operation by individual groups, or commercial third-party supply of vehicles and management (legislative changes are probably required for the latter). During the course of development an information package and background material have been compiled, and surveys have been undertaken to determine factors which effectively attract pool members.

Ontario Energy in Transportation Ltd. - Carburetion System (Jim Orgill)

An agreement was reached in November, 1982 to provide up to \$1.4 million funding to allow Selachie International Ltd. to complete development and manufacture and market their controlled pressure induction fuel delivery system. The Canadian invention is patented world-wide, and in contrast with conventional carburetors, it features two sliding throttle gates and barrel-centre fuel delivery. The device could lead to fuel savings in the 4 to 8 percent range, and is readily adaptable to alternative fuels. It is injection moulded from plastics. The current effort is to prove and market devices for two-stroke engines (by 1984), and subsequently to aim for the automobile market.

Ontario Energy Corporation (continued)

Ontario Alternate Energy Ltd. - Transportation Fuels from Wood Residues
(Helen Vanner)

Arrangements have been made for a joint venture with Weston Energy Resources Limited to construct a wood residue to ethanol pilot plant, with the objective of furthering technology for the supply of transportation fuels.

Teleride and SAGE Projects (W.A. Methven)

The Teleride system has been developed and proven as a means of continuous monitoring of the location of transit vehicles, and allows passengers to phone to determine the next two arrival times at their stop. Access to the system can increase transit use by 10 to 30 percent. In a joint venture with Sage Management Consultants, a computer based transit management and scheduling system has been proven. The system is considered complementary to Teleride.

Funding

The Corporation considers investment in energy-related projects which might otherwise lack financing, but which appear likely to provide a return at least equal to the Province's borrowing rate at the time of participation, and a positive impact in terms such as employment or improved technology.

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-refer to project listings for names

Publications

Material for public dissemination is limited to Annual Reports, general brochures, and information sheets on specific projects. Additional documentation may be available to organizations interested in research, development or demonstration projects of a similar nature to those of the Ontario Energy Corporation.

Ontario Research Foundation

Background

Founded in 1928, the Ontario Research Foundation (ORF) provides scientific and engineering assistance to industrial and government clients. Approximately 25 percent of ORF's revenue is the result of a grant from the province of Ontario; the grant supports the purchase of equipment and expansion into new fields of technology.

ORF has a full and part-time staff in excess of 400 and has a number of "centres" focussing on specific topics. Energy-related transportation activities are the responsibility of the Centre for Alternative Fuel Utilization headed by Dr. Alex Lawson.

Projects

The current activities of the Centre for Alternative Fuel Utilization includes propane, methanol, ethanol, hydrogen and vegetable oils. Methanol has been a fuel of special interest including:

- blends at low concentration (5%)
- blends at higher concentrations (10% plus)
- straight fuels in existing and/or modified gasoline engines
- straight fuels in special engines

Projects include the following:

(i) Methanol use in spark ignition engines.

- Work for Transport Canada continues on the development of a dual fuel pick-up system (two fuel tanks and equipment for emulsifying blend on-board vehicle).
- ORF is the operator of a low concentration methanol/gasoline vehicle demonstration (5% methanol, 5% co-solvents, 90% gasoline). Two test fleets are involved - a taxi fleet in Montreal and a company vehicle fleet (Celanese) in Mississauga. Participants in this program include Ontario Ministry of Energy, Ontario Energy Corporation, EMR and Celanese Canada.

Ontario Research Foundation (continued)

- (ii) Methanol/Diesel emulsions in diesel engines.
 - ORF has successfully demonstrated a methanol (25%)/diesel (75%) emulsion in a diesel tractor (2 stroke Detroit Diesel) in on-road tests. Project supported by EMR and Noval Technologies.
 - ORF tried methanol emulsion unsuccessfully with Cummins truck diesel and will test fumigation of Cummins diesel in test vehicle this spring. (Noval Technologies)
 - work on use of methanol as a partial substitute fuel for underground use of diesel engines (INCO)
- (iii) Mechanical performance and combustion characteristics of a conventional diesel engine. Engine tested with various blends of diesel and diesel/methanol fuels.
- (iv) Propane conversion kit testing. Some testing for kit manufacturers has been performed.
- (v) Conversion of spark ignition engine to stratified charge. Project is to look at conversion of Ford spark ignition engine to stratified charge operation on either gasoline or diesel fuel (participates to study include SNC Group and Transportation Development Centre).
- (vi) Program has just been started for Agriculture Canada on development of tractor using biomass derived fuels (e.g. ethanol, vegetable oils).
- (vii) ORF expects to get one of the Ford Escots manufactured for the California methanol vehicle demonstration and ORF will test this vehicle.

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Publication

A number of papers are available.

Government of Quebec

Background

Two ministries were contacted in the Government of Quebec - the Ministère de l'Énergie and the Ministère des Transports. No projects were reported by the Ministère de l'Énergie; a number of energy conservation and alternate fuels activities were noted by the Ministère des Transports.

Ministère des Transports du Québec

The Ministère des Transports du Québec (M.T.Q.) has no official transportation energy research program. However, two individuals are responsible for studying and promoting energy conservation. In addition, a number of energy related projects are initiated by a number of groups within the M.T.Q. as a regular part of on-going activities.

Projects

- (i) Study of alternative fuels; a report is being prepared which will include recommendations for government policy in this area.
- (ii) Conversion of Ministry vehicles to propane; four new and four existing vehicles have been converted. Evaluation of results is taking place.
- (iii) Energy advantages of ride sharing; a report has been prepared; see publications list.
- (iv) The role of the automobile; a report has been prepared; see publications list.
- (v) Data bank of transportation energy statistics.
- (vi) Road maintenance techniques; among the techniques studied has been the planing of existing asphalt roadways before resurfacing and the recycling of the removed material; the use of surface treatments as an alternative to resurfacing has also been studied.
- (vii) Construction materials; experiments have been conducted with a variety of different asphalt mixes.
- (viii) Roadway lighting; research has been conducted involving modified illumination standards and different light sources.
- (ix) The conversion of a number of ministry vehicles to run on compressed natural gas by the end of 1983.

Government of Quebec - Ministère des Transports du Québec (continued)

Funding

The M.T.Q. receives no outside funding for its energy R&D activities. The budget for transportation energy R&D is not separated from other related activities and is therefore unknown.

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Raymond Larouche (projects (vi) & (vii) only)
Chef, Division de la conservation des chaussées

Publications

Deschenes, Rodrigue C. L'avantage énergétique du covoiturage au Québec. Transports Québec, division des études intermodales, décembre 1982.

Lambert, Louise. Le rôle de l'automobile au Québec. Transports Québec, service des études, décembre 1981.

Truchon, Maurice. Les carburants alternatifs pour les transports routiers. Présentation au congrès de l'A.Q.T.R., mars 1983.

New Brunswick Government

Background

Two contacts made in the N.B. government:

- (i) Department of Transportation
- (ii) Energy Secretariat

The Department of Transportation has a number of internal programs which result from the dual objectives of cost effectiveness and energy conservation. The Department of Transportation cooperates with the Energy Secretariat putting forward projects for funding under the Canada/New Brunswick Conservation and Renewable Energy Development Agreement (CREDA).

Department of Transportation

Projects

- (i) Fuel Efficient Fleet and Equipment. Since 1975, the department has been changing its heavy equipment fleet from gasoline to diesel powered. For lighter equipment (half-ton, etc.) several things have been done to improve gas mileage. These include stepping down from V8 to 6 cylinder engines, moving from automatic to standard transmissions and installing some overdrive transmissions.
- (ii) Emulsion Asphalt. The Province has moved toward using emulsion asphalt rather than cut-back emulsion asphalt since the latter uses kerosene and other fuel oils. Projects are beginning this summer that will use the water based emulsion asphalt.
- (iii) Highway Design Projects. The Province has been improving its highways for the past fifteen years by installing passing lanes, city by-passes and improving vertical and horizontal alignment. These are ongoing projects which result in greater fuel economy.
- (iv) Asphalt Alternatives Study. Two alternatives to straight asphalt are being studied for road surfacing. These are concrete and composite pavement; the latter is made up of a concrete slab with a surface layer of asphalt.

New Brunswick Government - Dept. of Transportation (continued)

- (v) Asphalt Recycling Project. The Department of Transportation is now actively salvaging and stock-piling old asphalt pavements.
- (vi) Field Procedure Changes. On a more general scale, the Department has changed a few field procedures in the last few years to further conserve resources:
 - 1.) On profiling projects, cold milling or grinding the surface instead of padding depressions reduces the quantity of asphalt required and allows for salvaging of old material.
 - 2.) Granular material is now being salvaged and used for shoulders.
 - 3.) Pulverized chip seal is being used instead of padding.

These projects have proved cost effective and these practices will be used in the future.
- (vii) Main Highway Shoulder Construction. After 1978, the two meter wide shoulders of main highways were no longer completely paved. Currently, one meter is paved with the remaining three meters chip sealed. This has conserved both aggregate and asphalt while maintaining safety standards.
- (viii) Sodium Lamp Study. Most lamps on New Brunswick highways before 1979 were mercury-vapor type lamps. In 1979, the Department of Transportation switched over to low pressure sodium lamps on the Saint John Harbour Bridge to test their efficiency. All the existing 400 watt lamps were replaced with 90 watt low pressure sodium lamps. Within two years, the new installation had paid for itself.

Thus a decision was made to gradually switch over to low and high pressure sodium lamps and by 1985 this project should be completed.
- (ix) Highway Signs Project. Highway signs used to be lighted with overhead lights. The Department has now moved to replace these lights with highly reflective sign overlays.
- (x) Maximum Speed Limit Study. A study is currently being carried out on lowering the maximum speed limit on the main highways below the present 100 km/hr.
- (xi) Maintenance Buildings. Energy efficient maintenance buildings have been designed for the Department. Improvements include increased insulation, fewer overhead garage doors, and windows located only on the south face.

New Brunswick Government - Dept. of Transportation (continued)

- (xii) Vanpooling. Three vanpools have been organized by the Department.
- (xiii) Future Activities. Possible future activities include: A Truck Save type program which would include information to truckers and capital assistance for add-on equipment, a carpooling/dispatch centre program for smaller municipalities that are without transit services and a parking/shuttle bus scheme for St. John commuters.

Energy Secretariat

A number of CREDA projects with a transportation implication are the responsibility of the Energy Secretariat:

Projects

- (i) Electric Commuter Car. Improvement of the efficiency and general performance of an existing electric car (Mr. Tom Sisk, 236 Barton Cres., Fredericton, N.B. (506) 472-8833) (\$2,000).
- (ii) Lithium Battery Development as a transportation energy source. (Mr. H. Drummond, Director, Engineering Division, Research and Productivity Council, P.O. Box 6000, Fredericton, N.B. (506) 455-8994)).
- (iii) Hybrid Electric Car. Demonstration of the advantages of an electric car equipped with an on-board gas-powered electric generator used for battery charging (Mr. William Smith, 339 Dover Street, Campbellton, N.B.) (\$8,000).

Contact Persons

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Nova Scotia Government

Background

Two departments of the Nova Scotia Government were contacted: Department of Mines and Energy and Department of Transportation. Mines and Energy is the lead group with respect to transportation/energy activities in N.S.; Transportation is only involved in a minor way. Most of the funding for the activities comes from the Canada (DREE)/Nova Scotia Subsidiary Agreement on Energy Conservation.

Department of Mines and Energy

The Energy Management Division has energy conservation responsibilities; the Energy Engineering Division is involved in planning and project design.

Projects

- (i) Vanpooling. This project supported Vanpools Ltd. in the purchase of eight vans and the development of vanpool services (\$17,000 contribution).
- (ii) Waste Oil as a Diesel Fuel. Project supported the purchase of a fuel filter/separator unit by Kaizer Transport Ltd. (\$9,000).
- (iii) Commuter Parking Lots. Thirteen commuter parking lots have been built at major interchanges of highways leading to Halifax (\$41,000). The Department of Transportation is the operator of this program.
- (iv) Overview Study of energy conservation and fuel substitution opportunities in transportation (IBI is the contractor).
- (v) Propane Vehicles. Metropolitan Transit Commission (Halifax) will test some propane conversion; the idea is to establish whether a market for natural gas can be pre-built with propane.
- (vi) Department of Municipal Affairs (Larry Kettey). Teleride is being considered for Halifax.
- (vii) Marine Project. A Cort nozzle (shroud around propeller) is being tested on a Lunenburg scallop boat.
- (viii) Automobile tuning for fuel conservation and low emissions. Testing program run by Technical University of Nova Scotia (see entry).

Nova Scotia Government - Dept. of Mines and Energy (continued)

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Government of Prince Edward Island

Background

Contact in the Prince Edward Island Government was with the Department of Transportation and Public Works. A limited number of energy-related activities are reported for P.E.I.

Projects

- (i) Vanpooling. The Province of P.E.I. initiated vanpool operations four years ago. Initially five vans were purchased involving civil servants and were organized with the support of the province.
- (ii) Automobile tuning for fuel conservation and low emissions. Testing program run by Technical University of Nova Scotia (see) for two week summer period.
- (iii) Ethanol from cull potatoes. P.E.I. Energy Corporation entered into an agreement with a private firm to construct an ethanol plant utilizing cull potatoes. Project failed to proceed when the equipment supplier went bankrupt and alternative quotes for equipment indicated the project was not financially viable.

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Government of Newfoundland

Background

Two departments were contacted in the Newfoundland Government:

- (i) Department of Transportation
- (ii) Department of Mines and Energy

Very little energy-related transportation activities reported for Newfoundland.

Projects

- (i) Propane vehicle. Department of Transportation has one propane automobile; fuel consumption and maintenance costs are being monitored.
- (ii) Fishing vessel fuel consumption. The Department of Mines and Energy has two studies slated for this coming summer related to fuel conservation on fishing vessels. (Joint Provincial/Federal funding)

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4.2 Carriers

Air Canada

Background

Air Canada is the largest air carrier in the country; fuel consumption is a significant cost in aircraft operation and as such receives close scrutiny. Air Canada, as a Crown Corporation, participates in the Federal Government internal energy program and follows the Federal energy consumption guidelines where possible. Since the early 1970's Air Canada has made overall improvement in energy use efficiency of 15 percent.

Air Canada is organized such that the regions and branches now develop their own energy-related projects and report on these annually to Montreal Base. Montreal Base still coordinates and supplies aircraft engineering, ground equipment engineering and facilities design and engineering services.

Projects

- (i) Most of the major projects with respect to aircraft fuel consumption were completed 3 to 4 years ago. These include aircraft operating procedures and equipment modifications and improvements. Current practice is that fuel savings projects must show a two year payback; in the past projects with up to a 5 year payback were accepted.
- (ii) Air Canada tries to fit any equipment replacement in with other government programs, e.g., heating equipment replacement with the Federal Off-Oil Program. Air Canada has also participated with EMR in a solar demonstration and has 200+ solar panel installed at Montreal Base.
- (iii) Air Canada constantly reviews the basic trade-off between air speed, fuel consumption and other flight costs. As fuel prices have risen in the past few years, reduction in aircraft speeds have been instituted. Climb and descent procedures are also reviewed constantly.
- (iv) Air Canada is currently testing an aircraft performance management system that is designed to monitor the aircraft's flight on a real time basis and to essentially fly the aircraft in the most fuel efficient manner.
- (v) Air Canada continues to make longer term investments in new equipment and updates existing equipment to increase fuel efficiency. For example, a new Boeing 767 uses 26 percent less fuel than the DC8 it replaces, a re-engined DC8 uses 17 percent less fuel than an existing DC8.

Air Canada (continued)

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Canadian National

Background

Canadian National's extensive transportation activities include railway, trucking and marine operations. Energy planning responsibility is a corporate function and a corporate director in charge of energy resource planning is located in CN's Montreal Headquarters. In the operating sense, CN's Rail Regions suggest projects and are responsible for implementation; similarly CN Express and CN Marine carry out energy conservation programs.

Projects

The projects listed below illustrate the type of projects CN has instituted; CN activities to improve their fuel efficiency are extensive and go beyond items listed below:

- (i) CN Rail is experimenting in Toronto with the blending of 10 percent bunker oil with diesel fuel. If the fuel economy and maintenance associated with the blended fuel are acceptable, the use of the blended fuel will be extended to all regions.
- (ii) Improved fuel management systems are being implemented.
- (iii) The relationship between train speeds, fuel consumption and other operating costs are being studied.
- (iv) New friction reducing lubricating oils are being tested.
- (v) Each Region of CN Rail operates an energy management program which focusses on improving the energy efficiency of operations. Energy audits for railway facilities are performed and fuel substitutions result. Switching from fuel oil for space heating to natural gas is a continuing activity.
- (vi) Some vehicle conversions to propane vehicles have been tried and more propane vehicles are planned.

Funding

No overall budget for energy projects was given. However, capital budgets for energy conservation and energy-related operational changes are substantial.

Canadian National (continued)

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Canadian Pacific Limited

Background

Canadian Pacific Limited is a major Canadian corporation with extensive interests in the transportation sector - notably CP Rail, CP Air, CP Transport and CP Marine. Canadian Pacific Limited maintains a corporate Department of Research in Montreal; CP Ltd. both initiates research projects and also responds to requests for assistance from the operating companies. Some 70 percent of the Research Department's projects are for CP Rail. The operating companies also carry out their own research and development projects particularly on topics which involve operational improvements.

The following projects were identified as energy-related although energy concerns are often only one aspect of a project whose overall objective is improved efficiency and/or productivity.

Projects

Rail

- (i) Development of on-board instrumentation for both instantaneous and cumulative fuel consumption. Four locomotives have the testing equipment installed; the intent is to use this equipment in road tests to determine the fuel consumption effects of different rail equipment and operating strategies. The road test results will also be useful in confirming computer simulation models of operations (particularly speed restriction impacts).
- (ii) Reducing tare weight of rolling stock particularly cars suitable for container shipment.
- (iii) Alternative fuels. CP has been using a syncrude (from the Suncor plant) as a substitute for diesel fuel for a number of years.
- (iv) CP participates through the Association of American Railroads (Southwest Research Institute) in the testing of engines and engine components.
- (v) Research is in progress on steerable trucks in order to reduce wheel and rail wear. Reduced friction and better fuel economy would be attendant effects.
- (vi) CP has studied rail electrification on many of their routes. A recent review of the Vancouver-Calgary route indicated an insufficient cash flow and rate of return for electrification of that route.

Canadian Pacific Limited (continued)

- (vii) Many of the structures and buildings associated with rail operations are old and efforts are being made to improve energy efficiency through building energy conservation techniques and improved heating systems.
- (viii) As part of the Bombardier program to develop a new locomotive, CP will test European designed AC traction motors in an experimental locomotive.

Truck

- (i) All of the operational and add-on equipment such as air deflectors have been reviewed by CP Transport and adopted as appropriate.
- (ii) Alternate fuels (propane and CNG) are under active consideration.

Marine

- (i) All of CP's fleet of ships is now powered by slow speed diesels.
- (ii) All of the conventional fuel conservation techniques have been reviewed, e.g., slow steaming.

Air

- (i) Considerable efforts have been made to improve fuel efficiency including weight reduction in the aircraft and flight operational changes.

Funding

Canadian Pacific was unable to assign a budget figure to their energy-related R&D activities.

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Reimer Express Lines Ltd.

Background

Reimer Express is a for-hire trucking concern with head office in Winnipeg and operating from Montreal to Vancouver. Reimer operates over 300 tractors and 800 trailers.

Projects

Reimer's activities are of a practical testing nature. As diesel prices have increased, saving fuel has received a good deal of attention. Reimer have tested all of the add-on equipment and truck specification items - tires, thermal fans, gear ratios, air deflectors, lubricants, etc. - to determine which offer cost effective fuel savings. None of the testing could be classified as formal R&D; the testing, however, has been thorough. For example, air deflectors were tested with match tractor-trailer units over a specific route with the air deflector units switch from one vehicle to the other for a second run. As well, driver training programs have been part of Reimer's energy conservation efforts.

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Voyageur Inc.

Background

Voyageur, a major intercity bus company, spends about \$11,000,000 annually on diesel fuels. Interest in energy research began to increase markedly in 1979 with concern being focused on cost reduction and the use of alternative fuels.

Projects

- (i) Development of an energy efficient bus. This bus has been streamlined based on wind tunnel tests and equipped with modern power train components. Special attention has been given to the reduction of parasitic losses. Fuel economy is expected to be more than 30% better than the current fleet average (with Prevost equipment).
- (ii) Development of a bus similar to (i) with American Eagle.
- (iii) Speed limit reduction (to 100 km/h) and more attentive maintenance have reduced fuel consumption by \$1,000,000 per year.
- (iv) Future projects include: electronically shifted transmissions, electronically controlled fuel injection, air intake scavenging blower by-pass, and raminduction.

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Publications

Some internal documentation available from Henri Chardola.

4.3 Equipment Manufacturers

Bombardier - Rail and Diesel Products Division

Background

Bombardier is composed of several separate divisions but the majority of the energy related research is undertaken in the rail and diesel products division.

Interest in research has increased rapidly from three people in 1980 to 75 persons in 1983. Energy related research constitutes 50% of the divisions research activities. Bombardier has established the objective of a 13% decrease in fuel consumption of their locomotive by 1985 compared to 1980.

Projects

- (i) Evaluation of alternate fuels which includes tar sands based fuel and various mixes of #6 and #2 diesel fuel. The evaluation includes the effect of the fuels on engine wear, various engine performance measures and engine modifications which may be required.
- (ii) Development of a single cylinder engine for test purposes. Two engines will be built, each being exactly the same as one cylinder of Bombardier's 16 cylinder engines. This project was undertaken to reduce the amount of fuel consumed during fuel tests.
- (iii) Development of new freight locomotive. This locomotive will consume considerably less fuels through improved auxiliaries and controls, a new engine and a new transmission. The locomotive will be available in both DC and AC traction versions. The AC traction version will be capable of up to 50% better fuel consumption because of increased wheel to rail adhesion possible with more refined motor control. Brown-Boveri and Canadian Pacific are also involved in this project.

Funding

Total research funding is roughly \$9,000,000 per year of which \$4,500,000 is energy related. Roughly half of the funding is internal while the remainder is provided by I.T.C., T.D.C. and D.N.D.

Bombardier - Rail and Diesel Products Division (continued)

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Publications

Some internal documents available from T.D.C. (single cylinder engine),
D.N.D. (alternative fuels) and I.T.C. (new locomotive).

Canadian Fram Limited

Background

Canadian Fram conducts an active research program which includes a number of projects with direct or indirect implications for energy use in transportation. The company has a well equipped engineering facility/laboratory in its Chatham plant, including a controlled climate wind tunnel and semi-aeronic chamber, dynamometers, and extensive instrumentation. While Canadian Fram is part of the Bendix group of companies, its product line is unique within the group, thus allowing a relatively independent course in research and development in its production areas. Activities span the full range from conceptualization of a requirement, to prototype engineering and testing, to commercial product manufacturing and sale. Within the framework of a primary interest in developing automotive products suited to a mass market (i.e., essential hardware or technology for an average vehicle), the company appears willing to consider cooperation with other research facilities or manufacturers in initiating research activity. Current and anticipated activity involves various government agencies (NRC, EMR, Transport Canada), and major automobile manufacturers.

Projects

- (i) Pulley control devices. Belt driven automotive components are designed for "worst case" situations (e.g., power steering pumps for parking, coolant pumps for extreme high temperatures), and much of the time provide an unnecessary engine load, or even deleterious operating conditions. Since 1977, Canadian Fram has been undertaking research on systems to reduce or shed belt loads when associated components are lightly loaded or not required. A number of devices are now under test to slow or stop belt drives, either at the crankshaft or at individual components. Marketable products should be available within a couple of years, and appear capable of providing some 5 percent gain in fuel efficiency. In addition to fuel economy, the new devices offer potential for easier starting, faster warmup, and extended belt life.
- (ii) Electromechanical interfacing. Work is underway on systems to interface with electronic monitoring devices (e.g., transducer fed microprocessors) and provide mechanical operation of air valves. Such valves could assist in providing a smooth idle at lowered engine speeds, dumping air pumps as appropriate to emission control objectives, etc.

Canadian Fram Limited (continued)

- (iii) Fan design. Work is underway on blade design and fabrication for super-quiet fan systems. These will complement automotive designs in which improved engine efficiency will require fans which run-on after the engine is stopped.
- (iv) Non-ram engine cooling. Elimination of open-front grilles will be one of the major remaining steps in improving drag coefficients of vehicles. Work has been underway for a number of years on alternatives to traditional cooling systems including different locations for air intakes and radiators, and conceptual work on environmentally controlled closed chambers for engines. Incorporation of designs in new vehicles appears to be several years away.

Funding

The company commits approximately 2 percent of annual sales revenue to pure or applied research. Total product engineering costs are around the level of \$5 million per annum.

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Publications

M. Vashchuck and Ron Bolohan, "Variable Speed Radiator Cooling Fan Controller". SAE Paper 831017.

H. Charles and U. Schaub (N.R.C.), "Ram Air Effects on Air Side Coding System Performance of a Typical North American Passenger Car". SAE Paper 800032.

Canadian Methanol Canadien

Canadian Methanol Canadien (CMC) is a privately owned corporation whose goal is to commercialize the use of methanol as a vehicle fuel. The company opened the first methanol dispensing retail station in Winnipeg in 1980.

Projects

- (i) First retail methanol station opened in 1980. Station sells a straight methanol (essentially 90% methanol/10% gasoline and cosolvents) and a blend (11.5% methanol/gasoline and cosolvents). CMC has developed a dispensing unit which mixes the methanol at the pump and can blend methanol in any ratio.
- (ii) CMC has operated a fleet of vehicles in connection with their fueling stations.
- (iii) A second methanol station is being built (under contract to Manitoba Research Council/Industrial Technology Centre for fuelling vehicles in the methanol demonstration project).
- (iv) CMC has a Federal government grant (Enterprise Development Program - DREE & ITC) for the development of two more methanol stations plus specific research work on lubricating oil for methanol vehicles and exhaust gas heating for methanol vaporization.
- (v) Renfrew project: CMC has plans to develop a methanol production plant at Renfrew, Ontario. Plant has a proposed capacity of 100 million gallons per year and would use a feedstock composed of 20 percent wood wastes and 80 percent natural gas.

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Canertech Inc.

Background

Canertech Inc. is a Canadian energy technology investment company created by the Government of Canada in December 1980.

Canertech's mandate derives from Canada's National Energy Program goals of self-sufficiency and oil substitution. Its interests include biomass, solar, wind, wave, micro-hydro and geothermal energy conversion systems, and energy conservation products and services.

Canertech is a venture capital development company. Through equity investment in enterprises developing renewable energy conversion systems and conservation technology, Canertech intends to help commercialize innovative products and processes.

Canertech has committed funds to two alcohol fuels development programs; transportation fuel markets are a likely market for any commercial development that might occur.

Projects

- (i) **Ethanol from Cellulose.** This five year, \$20 million plus technology development program was begun in late 1981 with Canertech as the designated lead agency for Canada. The aim of the program is to develop and integrate the technologies required to extract ethanol from wood cellulose on a commercial scale. To the end, a pilot plant will be undertaken by the end of 1983 and a small scale commercial demonstration by 1986.
- (ii) **Methanol from Wood.** Canertech Inc., in partnership with the Quebec company, Nouveler Inc., will build a waste wood-fed synthesis gas plant at St. Juste-de-la-Bretenieres. With a major grant from the liquid fuels research and development program of Energy, Mines and Resources Canada, this project will utilize pressurized oxygen-fed fluidized bed gasification technology being developed by Omnifuel Gasification Systems. Successful demonstration of synthesis gas production will lead to the program's second stage - construction of a plant to convert the synthesis gas into methanol.

Canertech Inc. (continued)

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Publications

A series of newsletters on the Ethanol-From-Cellulose Programs are available which explain the details of the program and the progress to date.

Chrysler Canada Limited

Background

Canadian research by Chrysler tends to focus on applied engineering of variations in the company's traditional product line, and testing to determine the viability of new designs or technology. Generally, it would be an objective to incorporate Canadian developments into the product line in the short term. In the United States, in addition to comparable work to that undertaken in Canada, Chrysler undertakes research programs aimed at development of innovative technology or concepts. Incorporation into products in the short term is not necessarily the primary objective in this work.

Projects

(i) Propane Technology (Canada)

An ongoing program at Chrysler Canada is aimed at optimizing performance and driveability of propane-fueled vehicles, as a basis for improvements in a relatively new product line. The company aims to maximize "on assembly line" fabrication of propane vehicles, rather than relying heavily on "off line" modifications. Specific research objectives have included development of cold weather starting systems, improved cold weather vaporization, and optimization of mixture control, compression, and engine durability.

During 1981/1982 Chrysler undertook a demonstration program on behalf of TDC in which 14 prototype propane vehicles were placed in fleet service across Canada. Performance was carefully monitored, and problem areas investigated and corrections and modifications made. A public report is pending.

Consideration is currently being given to an arrangement for building a few highly optimized light duty propane vehicles which will incorporate findings of the TDC-sponsored demonstration program.

(ii) Other Research (primarily U.S.A.)

Proprietary research is underway in many aspects of automotive engineering including:

- aerodynamic design
- multi-point and throttle body injection
- variable displacement and other improvements for power steering and water pumps
- electronic controls on transmissions

Chrysler Canada Limited (continued)

(iii) General

Features incorporated or about to be incorporated in the product line, which will improve energy efficiency include:

- 5-speed transmissions
- turbocharging for selected models
- widespread use of steel belted tires (all 1984 cars and most 1984 trucks)
- propane options

Level of Activity

Approximately 8 engineers, plus support mechanics and staff, are involved on a fairly permanent basis in the propane technology research and development. While other Canadian engineering impacts on energy efficiency of products, it is not possible to directly associate staffing levels with energy research.

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Publications

Publication of research findings is not normally a primary objective, and publications are generally limited to reports on sponsored research and service manuals covering new products. Current energy-related material includes:

Eric E. Durance and Brian E. Griffiths, "Evaluation of Propane-Fueled Vehicles Designed for On-Line Production", Draft, December, 1981. Limited distribution from TDC pending final report.

Chrysler Canada Ltd. "Propane, Original Equipment by Chrysler Canada Ltd. - 1983 Service Manual Supplement", 1983. 28 pp.

Cummins Diesel of Canada Ltd.

Background

Cummins does not undertake any research in Canada. The Canadian office provides assistance in sales and technical matters to the company's agents throughout the country. Research activity is primarily centred at the company's manufacturing facility in Indiana.

Projects

Current work with implications for energy use includes research and/or incorporation of new designs including:

- (i) Demand flow cooling in which parasitic losses are reduced through thermostatic controls to eliminate the use of coolers when heat dissipation is not required;
- (ii) Modified exhaust manifold designs in which low-drag geometry is substituted for angular design;
- (iii) Compound turbocharging and the potential for passing surplus energy to the flywheel;
- (iv) Adiabatic combustion chambers and related reduction in energy loss to the cooling system and energy consumption in operating the cooling system.
- (v) Timing control systems, turbocharging modifications, etc., to increase power delivery from engines.

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Du Pont Canada Inc.

Background

Du Pont Canada is a supplier of tetraethyl lead to petroleum refineries. Du Pont Canada undertakes proprietary research and development work on new light weight and low friction materials which could indirectly impact on energy use in transportation.

Projects

The company's primary public service relating to transportation energy research is its ESCON (Estimated Consumption) gasoline demand model. The model was developed for corporate use and as a service for tetraethyl lead customers. Subsequently, it has been offered to public users, either in terms of provision of an information package and current base case forecast, or as a calculating tool into which a researcher can input his own projections of variables.

The ESCON model for Canada is national, though a similar model for the U.S. also includes regional capability. The basic objective is a set of projections of demand for regular and premium grades of both leaded and unleaded fuels. Input variables include historical and projected new vehicle sales, fuel performance standards and on-road relationships to these, average annual distance by vehicle type and age, etc. The model allows calibration to the most recent fuel sales data through incorporation of a "vehicle use factor".

At the present time ESCON is considered to be a fully developed and operational model. It is run on a routine basis with a relatively minor time commitment, and is not the subject of ongoing development work.

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Publications

Du Pont Canada Inc., "Forecasts of Gasoline Demand Through 1990", October 1982. 17 pp. approx.

Ethyl Canada Inc.

Background

Ethyl has had a lengthy involvement in the transportation energy field as a supplier of fuel additives, the most important of which are tetraethyl lead and more recently a manganese anti knock additive. The company is actively engaged in research to improve technology for emissions control and products to enhance fuel quality (performance and efficiency).

Projects

- (i) Fuel and Car Trend System (FACTS). FACTS is a computer based model for forecasting gasoline requirements by octane number and in leaded and unleaded categories. The Canadian model includes 6 regions, and within each region allows for specification of historical vehicle sales, future vehicle to driver ratios, vehicle survival rates, fuel efficiency and annual distance. Considerable detail is incorporated in terms of specification of major vehicle manufacturers, auto sizes and truck classes, increasing octane requirement with vehicle age, etc. The model is maintained in Canada, with updates as information becomes available, and major annual revisions. Ethyl will provide a copy of their latest base case forecast to interested parties. Special runs are primarily a service to anti knock product customers, but consideration would be given to limited provision of runs for others on a cost of service basis.
- (ii) Combustion Technology. Since the early 1960's, Ethyl has been conducting research in the United States and developing technology and equipment to reduce emission levels and improve fuel efficiency of vehicles using leaded fuels. Two innovations are of particular interest: the turbulent flow manifold (TFM), and the Ethyl Lean Reactor System. The TFM manifold provides a better air/fuel mix, allowing a leaner burn and reduced emissions and fuel consumption. The reactor system is tolerant of leaded fuels (does not use noble metals), simple, and extremely durable. Ongoing work on the TFM and reactor systems is aimed at adaptations and improvements for potential incorporation in future OEM vehicles. Activity is in the United States and Europe.
- (iii) Cetane Boosting. Research has recently been initiated in the United States on effects of diesel fuel quality and cetane number on fuel economy and other engine operation parameters. A primary concern from a corporate viewpoint, is the future role of cetane-boosting additives in provision of required volumes of adequate quality diesel fuels. This will complement the company's existing background for supplying suitable additives.

Ethyl Canada Inc. (continued)

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Names of individuals involved in specific research projects may be obtained from Ethyl's Toronto office.

Publications

J.M. Collins and G.H. Unzelman, "Diesel Trends Emphasize Cetane Economics, Quality and Prediction", May 11, 1982. 38 pp. plus appendices. American Petroleum Institute 47th Midyear Refining Meeting, Order No. 820-00002.

Ethyl Canada Inc., "Impact of Lead Antiknock Removal on Refinery Energy Consumption", January 1982. 40 pp. plus appendices.

Ethyl Canada Inc., "Ethyl's Canadian FACTS -- Fuel and Car Trends Systems", Annual computer runs, all Canada summary approx. 50 pp.

Ford Motor Company of Canada Limited

Background

Most research by Ford which is aimed towards innovation of new technology is conducted in Dearborn, Michigan. The Canadian operation has a close working relationship with Dearborn when a requirement arises to engineer new technology into products, and in turn Canadian developments and engineering may be transferred to affiliates in other countries for incorporation in their products.

Projects

- (i) Conceptual Research. Ford, in Dearborn, places considerable effort on pure research with potential for long term impacts on energy efficiency. Such work covers the full gamut of alternative fuels, body shaping, engine, transmission and torque converter technology, and mechanical system operation and controls. Specifics of areas of investigation are proprietary.
- (ii) Alternative Fuels. Ford appears to be the leading manufacturer in developing vehicles for non-traditional fuels (e.g., alcohols, compressed natural gas), and along with other manufacturers started offering a propane options in a number of 1982 models.

The market for neat ethanol vehicles in Brazil, in which Ford is the leading supplier, stimulated research on neat alcohol vehicles in the U.S. Research on compression ratios, emissions and component durability has been conducted at engineering and prototype testing levels, and the company is now building several hundred methanol-optimized Escorts on a special order basis (primarily for use in California). A joint Ford/oil company/provincial government project is currently under consideration in Canada whereby 16 Escorts would be tested over 1½ years to evaluate fuel additives for improving cold start and driveability.

Ford has developed an experimental prototype alternative fuel vehicle (AFV) suited primarily for city driving, and depending on configuration, fueled by propane, compressed natural gas or alcohols. Further work on natural gas fueling will be undertaken with the American Gas Association to study the feasibility of building dedicated CNG vehicles.

Propane options have been offered in past Granada and Cougar models and are now being offered in the LTD and Marquis lines. Relative to gasoline, these models feature higher compression, special piston rings, and modified timing. Work on propane fuel efficiency and emission levels is ongoing.

Ford Motor Company of Canada Limited (continued)

- (iii) Transmission, Torque Converters, Rear Ends. To improve fuel economy a number of changes and innovations have been incorporated or are planned. Automatic transmissions with fourth gear overdrive and lock-up are now included in larger models, and more emphasis is placed on manual transmissions in mid-size units. Rear end ratios are being changed to provide greater fuel efficiency at driving speeds. In addition a shift indicator light has been developed which is activated by engine speed and intake manifold vacuum monitors. It is incorporated in some 1983 models.
- (iv) Engines. During the past few years the emphasis in Ford's engine work has been improvement of fuel economy. Strategies include incorporation of electronic control systems, turbocharging, fuel mix swirl (resulting from stratified charge work), and throttle body and individual port fuel injection systems.
- (v) Aerodynamics. Work has been undertaken to improved aerodynamics and reduced drag in sheet metal shaping and other aspects of body styling. Many of these improvements have been incorporated. Modification of standard headlamp design and mounting has been recognized as an area for additional improvement.
- (vi) Weight Reduction and Downsizing. A great deal of effort has been directed towards use of lighter materials and alternative designs to reduce the weight of a given size of vehicle. In addition, a complementary objective has been to increase the utility and comfort of smaller vehicles, thus allowing the company to offer the compound benefits of lighter weight materials in smaller vehicles.

Funding

Research activity in Dearborn, much of which is energy related, involves hundreds of staff and millions of dollars in annual expenditure. Canadian input to Ford's energy research varies depending upon requirements of the time.

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General Motors of Canada Limited

Background

Work in Canada is oriented more towards development of products for the market than towards basic research. The General Motors facility in Warren, Michigan is the main centre for the company's research activity, and is involved in proprietary work relating to energy use including engine design, transmission and torque converter improvements, drag reduction, methanol fuels, etc.

Projects

(i) Engine Recalibration

Commencing in 1976 General Motors of Canada initiated work to improve fuel efficiency of systems designed for unleaded fuel. Work involved modification of timing, modification and removal of closed loop emission controls, and adaptation of conventional control devices. Improvements are incorporated in new vehicles.

(ii) Alternative Fuels

General Motors of Canada is responsible for developing propane vehicles for sale throughout the North American market. Initial work indicated inadequate durability in many of the "aftermarket" propane components which were available for incorporation in GM models, and work has led to refinement of a selected range of propane equipment. Other work has been aimed at determining modifications which should be incorporated in engines originally designed for gasoline fueling. Propane options will be offered by GM in the near future.

Funding

The level of energy-related research work in Canada cannot readily be identified as individuals are involved in various aspects of research and engineering.

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International Harvester Canada Limited

Background

International Harvester undertakes a limited amount of research work in Canada. A more diverse program is underway in the United States. Topics and results are considered proprietary.

Projects

(i) **Cooling Aerodynamics**

Alternative concepts for engine cooling in trucks are being tested in an effort to improve vehicle aerodynamics and reduce unnecessary energy use in cooling systems. Facilities of the National Research Council are being utilized. Findings are unlikely to be made public prior to introduction of related designs in products.

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KHD Canada Inc.

Background

KHD Canada Inc. is a subsidiary of the Kloeckner-Humboldt-Deutz A.G., a West German company specializing in the development and manufacture of air-cooled diesel engines covering an output range up to 500 hp and liquid cooled engines with outputs up to 10,000 hp.

Projects

An R&D program was begun in 1974 in Montreal to produce a new air-cooled diesel engine for the light and medium class truck market. The R&D Division's mandate is to develop a new family of engines named the FL 610, an engine of 4, 6 or 8 cylinders, naturally aspirated or turbo-charged, in the power range 80 hp to 220 hp. The V8 engine is now in its final stages of development and will be produced starting in October 1983 at a plant in Boucherville, Quebec. Advantages of the air-cooled design includes insensitivity to extreme climate conditions, simplified maintenance through the elimination of liquid cooling componentry and better fuel economy. A number of hand built engines have been made available to large fleet operations in the Montreal area for on-road testing. KHD's R&D Division currently employs 135 people of whom 27 are engineers and technologists and 65 are technicians and mechanics. When production begins, KHD will be the only manufacturer of diesel engines for road vehicles in Canada.

Contact Person

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Publications

P.J. Stezak and W. Vossmeier, "New Deutz High Performance Diesel Engines", SAE Technical Paper Series 810905.

Massey-Ferguson Limited

Background

Massey-Ferguson conducts an extensive research program involving facilities in several countries, and major funding and staffing commitments. Research thrusts are in the general areas of improving the efficiency of farm machinery and diesel engines and have significant implications in terms of energy use. As many projects are underway, and some are proprietary, it is appropriate to discuss two major research areas rather than specific projects.

Projects

A number of research projects have the general aim of improving efficiency of diesel engines. Areas of interest include:

- shape of combustion chamber and position of fuel injectors. Laser-doppler equipment is used to monitor fuel mix movement and combustion;
- reduction of parasitic losses and energy transfer to cooling systems, ceramic engine component technology;
- use of alternative lubricants which allow wider clearances between working components of engines;
- microprocessor controlled fuel delivery systems.
- computerized flexing stress analysis aimed towards minimization of block and head materials and weight for a given engine power requirement.

The second major research thrust is aimed towards improving the operating efficiency of farm machinery. A variety of sensing and microprocessor devices are under development and will result in ability of equipment to self-monitor its utilization. Automatic self-correction will be available to control speed and power to minimize wheel slip, to adjust cutters to speeds appropriate to crop density and moisture, etc. Fuel efficiency improvements in the 20 to 30 percent range are a realistic target.

Funding

Research and engineering is conducted at a number of locations and involves hundreds of staff and millions of dollars in annual expenditure. Main research locations in Canada are in Toronto (Engineering Group), and Mississauga (Central Electronics Group).

Massey-Ferguson Limited (continued)

Contact Person

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Pratt & Whitney Aircraft of Canada Ltd.

Background

Pratt & Whitney Aircraft of Canada (P&WC) is the member of the Pratt & Whitney Aircraft Group responsible for the design, development, manufacture, marketing and support of small gas turbine engines in air, land and sea applications - worldwide. P&WC is a subsidiary of United Technologies Corporation of Hartford, Connecticut. P&WC has the second largest engineering department (1,400 strong) in Canada in the private industrial sector.

Projects

P&WC is actively involved in improving the fuel efficiency of their existing engines and in designing and developing new fuel efficient engines. It is difficult, however, to separate energy-related activity from the basic engine design and development work. P&WC is supported by Transport Canada's Transportation Development Centre (TDC) in the design and development of more energy-efficient aircraft and engines of a size and type suitable for Canadian manufacture, marketing and application. The two projects funded by TDC are a mixed flow turbine study and the development of gas turbine ceramics technology.

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Urban Transportation Development Corporation Ltd.

Background

The Urban Transportation Development Corporation was established in 1973 by the Government of Ontario to foster Canadian technical innovation in the public transit industry. It was specifically charged with undertaking research and development to advance public transit technology, and with providing leadership in the marketing and implementation of its fully developed products in cooperation with its industrial partners.

In order to carry out its mandate UTDC has established four wholly owned operating subsidiaries: Metro Canada Limited (MCL), UTDC Research & Development Ltd., UTDC Services Inc. and UTDC (USA) Inc.

Metro Canada Limited is the delivery arm for hardware products developed and tested by UTDC. MCL acts as a prime contractor and project manager to oversee the design and construction of transit products including the Intermediate Capacity Transit System (ICTS), the Canadian Light Rail Vehicle (CLRV), and other hardware components such as steerable axle trucks.

UTDC R&D is expanding the corporation's research and development activities into areas such as transit systems technology, power distribution, alternate fuels, and a wide range of transit components.

UTDC Services Inc. provides a full range of advisory or consulting services in transit maintenance, management, and training. UTDC (USA) Inc. is based in Detroit, Michigan and markets UTDC products and services in the United States.

UTDC as a partner in a joint venture company will produce, assemble and supply transit vehicles.

UTDC's test facilities permit both static and running tests of propulsion, suspension and automated train control equipment plus switching and other operations. The laboratories and computing centre can be used for design and development of new equipment and systems.

Projects

- (i) **Vehicle Systems.** In the broad sense, UTDC's major equipment developments such as the Intermediate Capacity Transit System (ICTS) and the light street cars (with regenerative braking) are examples of energy efficient people-mover systems.

Urban Transportation Development Corporation (continued)

- (ii) **Flywheel Energy Storage.** UTDC has carried out two studies for Transport Canada; an assessment of the technical and commercial feasibility of developing flywheel energy storage technology for transit application (1976/77 - \$72,000) and the design, construction and testing of a flywheel energy storage system for a diesel bus. (1979/80 - \$750,000).
- (iii) **Hydrogen Bus.** UTDC had a contract with the Ontario Ministry of Energy (1981/86 - \$6,000,000) to develop hydrogen storage and fuel systems and equip two demonstration transit buses to use hydrogen. This project was cancelled in July, 1982 after the preliminary design work on the hydrogen storage and fuel systems was completed.
- (iv) **Diesel Transit Bus Market.** UTDC has recently completed a technical and cost study of the diesel transit bus market looking at a variety of alternative fuels - propane, CNG, LNG, and methanol. A report to the Ontario Ministry of Energy is complete; LNG is identified as an interesting and viable option.
- (v) **Sail Rail.** Sail rail is an innovative system where a pallet/vehicle is supported by two compliant tubular cushions that move along concave tracks; compressed air is discharged through small holes in the track permitting the pallet/vehicle to glide easily in a controlled manner. UTDC is experimenting with the addition of linear synchronous motors as the driving force for such a system and see applications of the combined technology in the people mover and industrial fields.
- (vi) **Future Activity.** LNG fuel systems for urban buses (injection type engine), improvements for inducting gaseous fuels in diesel engines, fuel cells, advanced batteries (sodium/sulphur cells), continuously variable transmissions are planned activities of the R&D Division.

Funding

UTDC R&D Limited has a staff of about 35 engineers and technologists. Total annual budget is roughly \$3 million with most of the funds coming from contract research for governments and private clients.

Contact Persons

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4.4 Universities

University of British Columbia - Centre for Transportation Studies

Background

This organization undertakes research in various areas of transportation, with particular reference to economic questions, managerial problems, transportation planning, and the relationships between transportation organizations and government.

The Centre for Transportation Studies is regularly involved with the Faculty of Commerce and Business Administration; the School of Community and Regional Planning; and the Departments of Economics, Geography, and Civil Engineering. It has occasional involvements with other facilities, schools, and departments of the university.

The Centre for Transportation Studies generally engages in research of a policy nature, dealing with projects that are of interest to some government organization.

Projects

The Centre does not presently have any research underway dealing with the use of energy for transportation. One book dealing with the topic: Energy for Transportation - Its Availability, Its Cost and Its Conservation has been published.

Contact Person

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Publication

Energy for Transportation - Its Availability, Its Cost, and Its Conservation, available from Centre for \$18.00.

University of British Columbia - Mechanical Engineering

Background

The Alternative Fuels Laboratory, Department of Mechanical Engineering, has recently been established to perform basic combustion research on alternate transportation fuels. The Laboratory is the responsibility of Drs. Philip G. Hill and Robert L. Evans; staff includes two research engineers plus technicians. Engine test equipment includes a four cylinder spark ignition engine, a four cylinder diesel engine, a one cylinder CFR engine and a Ricardo Hydra.

Projects

The focus of the Laboratory's research is on natural gas as a fuel. Specific research topics includes:

- (i) Low flame speed of natural gas. Fuel mixtures and additives to enhance flame speed. Enhancement for flame speed through improved turbulence in the combustion chamber.
- (ii) Utilizing the high octane number of natural gas. Use of turbo-charging to take advantage of the high octane number in dual fuel configurations.
- (iii) Natural gas/diesel. Investigation of indirect injection diesel engines with diesel fuel as a pilot only. Knock limited performance.

The Alternative Fuels Laboratory/Mechanical Engineering cooperates with B.C. Research in the investigation of CNG as a vehicle fuel. The Alternative Fuels Laboratory undertakes fundamental engine/combustion work and B.C. Research the applied research activities.

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Publications

Laboratory reports are available by writing Dr. Evans.

University of Calgary - Institute for Transportation Studies

Background

The Institute for Transportation Studies brings together faculty from a number of departments for cooperative transportation research projects. The energy-related transportation research is centered in the Department of Civil Engineering.

Projects

- (i) Potential Energy conservation in urban commodity flow (urban goods movement). This report documents the energy consumption in urban trucking in Calgary and reviews certain energy conservation techniques. See publications listed below. (John Morrall - Civil Engineering)
- (ii) Automobile energy conservation in urban transportation. Completed in 1980, this work was funded by EMR. See publications listed below.
- (iii) Future activities. Supported by a Natural Sciences and Engineering Research Council (NSERC) operating grant, plans are for research under the general heading of efficient use of energy in the transport sector. Specific research topics include: energy efficiency comparisons of truck vs. rail, alternate fuels, and reduced use of asphalts (recycling of existing pavement).

Contact Person

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Publications

Potential Energy Conservation in Urban Commodity Flow, Volume 6, Urban Goods Movement Report Series, prepared by the Department of Civil Engineering for the Urban Transportation Branch of Canadian Surface Transportation Administration, Transport Canada, December 1978.

M.A. Sargious and Szyplett, "Some Measures of Energy Conservation in Urban Transportation in Canada", Journal of Energy and Development Volume V, No. 1 (Autumn 1979).

Canadian Energy Research Institute (University of Calgary)

Background

Founded in 1975, the Canadian Energy Research Institute (CERI) is a co-operative research organization sponsored by the Alberta Department of Energy and Natural Resources, Energy, Mines and Resources Canada, the University of Calgary, The Private Energy Research Association - a consortium of corporate and individual members from the oil, gas, coal, electrical, nuclear energy and pipeline industries - and the Ontario Ministry of Energy.

CERI's charter established the Institute 'for the purpose of carrying out studies, investigations and projects related primarily to energy and energy policy.' This mandate enables the Institute to develop a Canadian research capability in energy economics by undertaking and commissioning studies on energy-related problems for government and industry.

CERI has completed a number of transportation related energy studies, mainly in the area of alternative transportation fuels and the comparative economics of alternative fuels with conventional fuels.

Projects

- (i) Alternative Transportation Fuels in Canada (1982).
- (ii) Alternative Future Supplies of Oil in Canada and their Costs (1980).
- (iii) Methanol Development Options (1983).
- (iv) It is anticipated that a project comparing the cost of refined petroleum products from oil sands with methanol (on an energy content basis) will be undertaken in 1983.

Funding

CERI is supported financially by the three governments noted above and by the Private Energy Research Association. The University of Calgary provides the Institute with full access to its research facilities and acts as trustee and accountant for the Institute. Additional revenues are obtained by contract research activities. Approximately half of the Institute's activities are funded internally and half are contract research activities. The approximate budgets for the three projects noted above are: Alternative Transportation Fuels (\$50,000), Alternative Future Supplies of Oil (\$30,000), and Methanol Development Options (\$50,000).

Canadian Energy Research Institute (University of Calgary) (continued)

Contact Person

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Publications

CERI publish the results of research. Reports for the projects (i) and (ii) above are available and the report for the project (iii) should be available in the near future.

University of Manitoba - Centre for Transportation

Background

The Centre for Transportation at the University of Manitoba brings together individuals from a number of departments with transportation interests. The Centre does not focus on energy related transportation research but some research has energy implications.

Projects

- (i) Fuel economy performance of large trucks. Identification of the relationship between GVW and fuel economy; also summer to winter variations (Alan Clayton - Civil Engineering).
- (ii) Implication of the highway strengthening program and the effects of further relaxation of load limits (Alan Clayton - Civil Engineering).
- (iii) Price Elasticity of Air Travel. Mathematical modeling of air travel demand and dependent variables including fuel consumption and cost (Afi Soliman - Civil Engineering).
- (iv) Electrical Drive. Electrical engineering has worked on numerous aspects of electrical drives, e.g., chopper control of D.C. motors on Flyer trolleys (R.M. Mathur - Electrical Engineering).
- (v) Thesis entitled "An Analysis of Urban Density and Travel Distance Interrelationships and their Energy Implications in Large Canadian Cities" (supervised by Ralph Harris - Economics Department).

Contact Persons

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Publications

A.H. Soliman and J.L. Brown, "Air Transportation and Energy - A System Management Approach", Transportation Quarterly, Vol. 37, No. 1, January 1983.

**University of Toronto - York University
Joint Program in Transportation**

Background

The Joint Program was established in 1976 in response to a 1970 request by the Canadian Transport Commission for proposals for regional university-based transportation research centres. Primary objectives include encouragement of research relevant to improved transportation in Canada, provision of information and expertise to government and industry, and assistance in coordination of high quality transportation teaching and research in the two universities. These objectives are met through both internally generated and externally requested (contracted) research; sponsoring seminars, conferences and special courses*; and release of working papers, research reports, major papers, and conference proceedings.

Energy topics have been included in Joint Program research since about 1980, but constitute a relatively small portion of the total research activity.

Projects

- (i) A Work Program for the Collection of Canadian Household Data Relating to Automobile Ownership, Trip Making and Transport Fuel Usage (E.J. Miller, R.A. Wolfe, M.K. Berkowitz)

Research involves nation wide data collection as a basis for development and calibration of models describing household automobile ownership, and trip-making behaviour. The first phase, completed in early 1983, involved a data acquisition survey and development of models. Expansion to an operational model during 1983/1984 will allow exploration of policies concerning gasoline conservation, including fleet composition regulations, gasoline pricing strategies, and public transit subsidies.

* The Joint Program is not responsible for teaching routine university courses and does not enrol students.

University of Toronto - York University
Joint Program in Transportation (continued)

(ii) Energy Consumption of Alternative Transport Modes (E.J. Miller, R.M. Soberman)

Research led to development of models determining modal energy efficiency based on physical characteristics of the vehicle and the nature of its service cycle. Models are most developed (used as teaching tools but not extensively validated) for transit modes including diesel bus and LRT. Limited work has been done on rail and air.

(iii) Energy Efficiency In Transport (R.M. Soberman)

Research is designed to determine conditions under which various modes perform more efficiently from the standpoint of energy consumption per unit of utilization (i.e., considering both physical efficiency and load factors). Consideration may then be given to the impact on energy efficiency of alternative transportation policies.

Funding

The Joint Program is self-financing and intended to make a reasonable contribution to university overhead. Funding is provided in the form of general grants (Transport Canada - Strategic Planning, Energy, Mines and Resources Canada), directed grants (e.g., National Sciences and Engineering Research Council), and contracts for research for institutions or corporations.

Contact Persons

Richard M. Soberman, Director
Edgar J. Dosman, Assistant Director (York)
Gerald N. Stewart, Assistant Director (U of T)
Eric J. Miller, NSERC Research Fellow

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University of Toronto - York University
Joint Program in Transportation (continued)

Publications

University of Toronto - York University, Joint Program in Transportation;
Annual Report: Provides a summary of recent and current projects and a
listing of research reports (83), transportation reprints (12), transportation
papers (6), working papers (11), books and monographs, symposium and
conference papers and proceedings.

Energy-related titles include:

R.M. Soberman et al, "Energy Consumption of Alternative Transport
Modes, Draft Report", September 1981. 100 pp. approx.

D. Sims and E.J. Miller, "Energy Consumption of Alternative Fixed Route
Transit Modes", September, 1981.

G. Desfor and L. Haas, "Energy Requirements for Urban Goods Movement",
April, 1979. 104 pp.

Canadian Institute of Guided Ground Transport (Queen's University)

Background

The Canadian Institute of Guided Ground Transport (CIGGT) was created in 1970 by the Canadian Transport Commission, Canadian National Railways, Canadian Pacific Limited and Queen's University. Its primary function was to carry out railway-related investigations — short and long term — to improve the Canadian transportation system. The current sponsors include Canadian National Railways, Canadian Pacific Limited, Transport Canada, VIA Rail Canada Inc., UTDC R & D Ltd. and Queen's University.

The goals or purposes of the Institute are:

- (a) to carry out investigations and research - short and long term - in order to improve Canadian guided ground transportation systems.
- (b) to develop a scholarly interest in transportation among undergraduate and graduate students, faculty members and industry employers.
- (c) to provide a reference centre of Canadian ground transportation technology and research to facilitate coordination and liaison within the industry.

CIGGT obtains a portion of its operating revenues from annual base funding allocations made by each sponsoring agency. Most of the remainder results from overheads received as a result of research projects undertaken by full-time CIGGT researchers and academic associates. Miscellaneous revenue sources, including equipment rental fees, contribute further to CIGGT's operation.

Projects

Since its inception CIGGT has been involved in a number of issues/topics that have energy implications including:

- Arctic Rail Study
- Magnetic Levitation and Linear Synchronous Motors
- Rail Electrification
- Flywheel energy studies (with UTDC)
- Modal selection for movement of Western Canadian coal to Ontario
- Canadian Railway Energy Conservation and Alternative Fuels
- Railway diesel fuel from coal

CIGGT (Queen's University) (continued)

Current energy-related project titles include:

- A Research and Development Program for Railway Electrification in Canada (\$10,000).
- An Analysis of the Benefits of Railway Electrification to the Province of Manitoba. (\$40,000).
- Alternative Fuel Sources (\$14,500).
- Sponsors Research
 CN-Fuel Usage
 VIA Rail - Energy Conservation and Petroleum Subsidies

Funding

Total CIGGT staff during 1981/82 was 19. Total research expenditures in 1981/82 amounted to \$663,000. No estimate is available of the proportion of total expenditure that is energy related.

Contact Person

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Publications

CIGGT publishes most of their research and a list of publications can be obtained from the Institute. CIGGT also maintains an extensive library of railway related material.

Carleton University - Transportation Research Centre

Background

The objective of the Transportation Research Centre is to foster co-operative transportation research of interest to members of a variety of departments at Carleton. The Centre combines the experience of the investigators in transportation policy, planning, technology, regulation, administration, and economics. Graduate work in transportation research is considerably strengthened through the activities of the centre.

Projects

- (i) The Efficiency of Intercity Rail and Bus Transportation Systems — Sponsored by NSERC 1981-85.

This project is aimed at the identification of means to enhance the energy efficiency and overall cost-efficiency of intercity rail and bus transportation systems. Technological, system and management means for efficiency improvements are under investigation (Harry Valentine - research assistant).

- (ii) Areas of Opportunity for the Use of Telecommunications to Substitute for, or Complement Transportation — Sponsored by the Ministry of Transportation and Communications, Ontario 1982-83.
- (iii) Energy Efficiency of Intercity Passenger Transportation, Modal Shifts and Energy Conservation — Sponsored by Transport Canada's Strategic Studies Branch, Transport Canada's University Programmes and The Science Council of Canada 1978-1981.
- (iv) Financial and Energy Efficiency of Urban Transportation Systems — Sponsored by NSERC 1978-1981.
- (v) Railway Electrification: Energy Implications — Sponsored by the Science Council of Canada 1980.

Funding

Sources of funding (sponsors) have been identified under projects. The funding levels have been modest in all cases.

Carleton University - Transportation Research Centre (continued)

Contact Person

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Publications

"Intercity Passenger Transportation: Energy Consumption Characteristics; Transportation Planning and Technology, V6, pp. 249-262. Authored by A.M. Khan (1981).

"Intercity Passenger Transportation: Energy Efficiency and Conservation Case Study", Transportation Planning and Technology, V7, pp. 1-9. Authored by A.M. Khan (1981).

"Energy Efficiency of Electrified Passenger Railway in the Canadian Context", Journal of Advanced Transportation, V14, No. 3, pp. 237-254. Authored by A.M. Khan (1980).

"Urban Public Transit Efficiency: Economic and Energy Factors". Journal of Advanced Transportation, V15, No. 3, pp. 213-230. Authored by A.M. Khan (1981).

"Urban Transportation Energy: Policy, Planning and Technology Factors", RTAC Annual Conference, Halifax, September 20-23, 1982. Authored by M.R. Campbell and A.M. Khan.

"Railway Electrification: Energy Implications", Science Council of Canada, Opportunities in Canadian Transportation. Authored by A.M. Khan (1980).

"Energy Implication of Railway Electrification in Canada", RTAC Forum, V3, No. 3, pp. 96-102. Authored by A.M. Khan (1980).

**University of Montreal - Ecole polytechnique
Civil Engineering Department**

Background

The transportation section of the Civil Engineering Department has no specific objective to encourage transportation energy R&D but does so indirectly by undertaking research related to more efficient transportation systems and better road infrastructure.

Projects

- (i) Refinement and application of the Integrated Civil Engineering System (ICES) program which develops optimum roadway alignments based on minimizing the total of construction, maintenance and vehicle operating costs. Fuel used by motor vehicles is included in the cost.
- (ii) Reduction of petroleum based components of asphalt mixes by 50% (with Desourdy Construction).
- (iii) Use of shale as an aggregate in road construction. The use of shale, which is readily available in the vicinity of road construction and maintenance projects, reduces the cost of transporting necessary construction materials.

Funding

Energy related research absorbs about \$50,000 per year. The majority of funds is provided by the Natural Sciences and Engineering Research Council although the private sector and the University provide some funding.

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University of Montreal - Ecole polytechnique
Civil Engineering Department (continued)

Philippe Manseau
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Publications

L'utilisation du schiste dan les melanges bitumineux, Canadian Technical Asphalt Association, Annual Conference 1981.

Evaluation du comportement des chaussees construites d'agregats marginaux et de schiste.

Utilisation du schiste dans le beton.

Bibliography of Documents on the Use of Shale as a construction Material.

Utilisation des agregats marginaux dans la construction, O.E.C.D.

**University of Montreal
Centre de Recherche sur les Transports**

Background

The Centre de Recherche sur les Transports (CRT) is one of the major centres of transportation expertise among Canadian universities. It has an annual research budget of \$700,000. The CRT stresses a multi-disciplinary approach to transportation research and has historically stressed computer science and operations research. The CRT has no objective relating to energy research.

Projects

- (i) Measuring the fuel cost of urban congestion. The assignment module of the EMME/2 program has been modified to include a fuel consumption estimated based on time and distance travelled. Congestion was found to account for 30% of fuel consumed for the Winnipeg O-D matrix which included 87% work trips. Estimates have also been made of the effects of cold weather, different fleet mixes. In the future the intention is to develop a full energy impact module for the EMME/2 program.
- (ii) Winnipeg automobile ownership analysis. A comparative analysis of car registrations in Winnipeg was undertaken for 1976 and 1981. Among the conclusions of the study was the fact that new cars represented only 11% of the fleet in 1981, compared to 21% in 1977. It was also found that the more well off areas of the city had a higher than average proportion of new, efficient and light vehicles and gas taxes can be viewed therefore as regressive.
- (iii) Analysis of freight commodity flows in Brazil. Analysis of the energy impacts of different technologies on existing and future commodity flows (with the Catholic University of Rio de Janeiro and the Brazilian Ministry of Transport).

Funding

Project (i) above \$10,000 (Natural Sciences and Engineering Research Council),
Project (ii) above \$12,000 (Transport Canada), and
Project (iii) above \$389,000 (International Development Research Centre)

University of Montreal - Centre de Recherche sur les Transports (continued)

Contact Person

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Publications

Paper resulting from project (i) above: On Network Equilibria with Generalized Cost Functions (with application to fuel consumption impacts).

A document related to project (ii) above is in progress.

**Laval University
Mechanical Engineering Department**

Background

The Mechanical Engineering Department has considerable expertise in aerospace engineering. Transportation energy R&D is limited to combustion research. The combustion laboratories were instituted fifteen years ago and today have very extensive facilities.

Projects

- (i) Combustion modeling by computer. This has been a long term research activity.
- (ii) Theoretical examination of the effects of oil sands derived fuels on aircraft engines.
- (iii) Analysis of 40 different potential aviation fuels which have been synthesized from pure substances. The analysis includes measurement of combustion efficiency, carbon formation, flame radiation, etc.
- (iv) More detailed analysis of the 40 fuels mentioned in (iii) above.
- (v) Effects of the addition of methanol, ethanol and isopropanol to automotive fuels (energy efficiency, pollution, knock, etc.).
- (vii) The effects of pulsed sound on the mixing of hot gases (with Calgary University).
- (viii) A future project is high pressure testing of the 40 fuels mentioned in (iii) above.

Funding

The combustion laboratory has had a research budget of \$200,000 to \$300,000 for the last several years. Current funding is provided by NSERC (\$50,000) and DND (six figures).

Laval University - Mechanical Engineering Department (continued)

Contact Persons

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same address

Publications

A substantial number of papers have been published by J. Odgers and others. A list of papers can be obtained by writing J. Odgers.

University of New Brunswick - Transportation Group

Background

The University of New Brunswick Transportation Group, established in 1967, operates through a co-ordinator and draws together faculty members from engineering and economics with an interest in transportation issues. The Group comprises five faculty members and usually about ten graduate students. The Group's projects cover a wide variety of transportation issues; some projects look at energy issues and implications.

Projects

- (i) Highway cost allocation study (N.B. case study). The energy component of highway costs was considered.
- (ii) Trucking costs in the forest industry. Importance of fuel costs within the operating cost structure of the industry was evaluated.
- (iii) Energy intensity of regional airports. Energy audits of regional airports was attempted.
- (iv) Role of the broker in for-hire trucking. Miles per gallon differences between brokers and non-brokers was documented.

Funding

The University of New Brunswick Transportation Group is supported by NSERC, Transport Canada, provincial government, and by contract research. No specific energy funding for projects was identified.

Contact Person

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Publications

F.R. Wilson, R.J. Hall and J.D. Innes, "Energy Consumption at Canadian Airports", presented to the Annual Meeting of the Transportation Research Board, Washington, D.C.

Technical University of Nova Scotia - Centre for Energy Studies

Background

The Centre for Energy Studies was established at Nova Scotia Tech in 1978. Its objective is to promote research and development, and education in energy studies in Nova Scotia.

The basic resource of the Centre is the talent and facilities that reside within the faculties of Architecture and Engineering, but the role of the Centre includes the promotion of interaction between these resources and the resources of the community.

The Centre is involved in co-operative projects with private consultants, government, industry and university in several areas such as combustion of solid fuel, gasohol production, and fuel economy of automobiles.

The Centre has established a combustion laboratory for testing and research on fuels such as wood, coal and coal/oil mixtures and on combustion devices (not an engine laboratory for testing transportation fuels).

Projects

Projects which can be categorized as energy related transportation projects fall into two groups:

- (i) Alternate fuel production. A pilot plant for production of ethanol from potatoes is being tested (funding from Agriculture Canada).
- (ii) Automobile tuning for fuel conservation and low emissions. The Centre has been involved in auto tuning over the last three years - including two week long tests in Halifax, N.S. and Charlottetown, P.E.I. The success of the program and its acceptance by automobile owners has lead to the establishment of a permanent test facility in Halifax in January, 1982. To date, 7000 vehicles have been tested.

Funding

The Centre's support for its overall program exceeds \$500,000. The auto tuning projects funding has been relatively modest (approximately \$50,000).

Technical University of Nova Scotia - Centre for Energy Studies (continued)

Contact Person

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Publications

G.S. Trivett, "Auto Tuning for Gasoline Conservation and Low Emissions: Experience Over a Three Year Period", presented at Energex '82, August 29, 1982.

G.S. Trivett, "Report On: 1982 Summer and Fall Automotive Testing and Adjustment Program", Centre for Energy Studies, Dec. 22, 1982.

Canadian Marine Transportation Centre (Dalhousie University)

Background

Canadian Marine Transportation Centre (CMTC) was established in 1977 with financial assistance from Transport Canada, the Province of Nova Scotia and Canadian National. The goals of the Centre are to promote understanding of marine and intermodal transportation issues relevant to Canada through teaching, research and information dissemination both within and outside the university.

Research work is supported by both public and private sectors, with the principal funding coming from the federal Transport University Program. Grants are awarded for proposals that both enhance the research capabilities of students and address questions considered to be of relevance to Canada. CMTC fosters interdisciplinary research by recruiting faculty and students from various disciplines for all its projects.

The base staff of the Centre is purposely small, consisting of a Director and Administrative Assistant. The Director is on the faculty of the School of Business, which permits direct involvement in teaching. Faculty are recruited throughout the university, and on occasion from other universities, on a project by project basis. There are very close cross links between the members of the Dalhousie Ocean Studies Programme and CMTC.

Projects

- (i) Technological Change in the Shipping Industry: The Coming Two Decades, Research Report No. 5 (Mary R. Brooks).
This review of technology changes in the shipping industry includes a discussion of fuels and marine engine technology and the technological response of the shipping industry to changing fuel types, their price and availability.
- (ii) The Marine Engine Industry (Douglas B. Raymond).
Essentially a study of the structure of the marine engine industry.
- (iii) CMTC has been asked by the Marine Advisory Board to initiate a series of seminars on technical and economic issues effecting the marine industry. The second seminar is expected to be on marine power units.

Canadian Marine Transportation Centre (Dalhousie University) (continued)

Contact Person

John Gratwick
Director
Canadian Marine Transportation Centre
Dalhousie University
1321 Edward Street
Halifax, Nova Scotia
B3H 4H9
(902) 424-3876

Publications

CMTC publishes their research. The first two studies discussed above are available.

4.5 Associations

Air Transport Association of Canada

Background

The Air Transport Association of Canada is the national organization for the Canadian commercial air transport industry. The current membership of ATAC accounts for approximately 95 percent of commercial air transport revenue.

Projects

A survey of the energy aspects of the Canadian airline industry have been completed by EMR in cooperation with the Air Transport Association of Canada. The report outlines the current status of the Canadian airline industry's energy performance and the energy management programs undertaken within the industry. The study also provides an aviation energy management information base developed through a comprehensive computer bibliographical review.

Contact Person

Gordon E. Lindsay
Vice-President, Government Affairs
Air Transport Association of Canada
747 Metropolitan Life Building
99 Bank Street
Ottawa, Ontario
K1P 6B9
(613) 233-7727

Publications

Energy Management in the Canadian Airline Industry, prepared by Majes S. English Associates Limited for Transportation Energy Branch, EMR.

Canadian Automobile Association

Background

The Canadian Automobile Association is a non-profit federation of motor clubs with offices and branches serving more than 2 million members throughout Canada.

CAA was founded in 1913. Its scope of operation has two basic purposes, first: to provide its members with a wide range of auto and travel-related services and second, to work on behalf of the best interests of the motoring and travelling public through legislative and educational activities.

One of the CAA's concerns is a continuing supply of motor vehicle fuel; CAA works closely with governments, the motor vehicle and automobile service industries, and the media to bring to all motor vehicle owners and operators an awareness of the fuel economy of different vehicles and the benefits of good driving habits and proper vehicle maintenance.

Projects

- (i) Autopinion. The Autopinion program, begun in 1980, is a service for buyers of new automobiles. Skilled CAA personnel evaluate new car models for a three week period; each model is evaluated for performance, braking, finish, noise, etc. and the results made available to CAA members and to the public.
- (ii) Vehicle Durability Survey - Used Car Buyers Guide. The Guide presents in concise form the opinions of Canadian motorists on how their personal automobiles have performed. The Guide also presents a variety of data on imports versus North American products, frequency of repair records and operating costs. The 1982 publication is based on a spring 1982 questionnaire; a total of 22,000 questionnaires were received and analyzed.
- (iii) Operation Tune-up. The CAA participates with EMR and certain provinces in a public awareness program related to energy consumption and emission levels.
- (iv) Future Activity. The CAA is an organization with a substantial direct contact with the motoring public and is potentially a useful source of a variety of information related to automobile fuel consumption, annual mileage, safety, reliability and durability, etc. The CAA performs 70,000 vehicle inspections annually, one million road service calls and has 1250 approved repair garages. The CAA feels that a systematic bringing together of information from these sources into a single data base could provide a useful source of data at a relatively modest cost.

Canadian Automobile Association (Continued)

Contact Persons

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K2C 3J2
(613) 226-7631

Richard J. Godding
Project Manager/Transportation Planning
Canadian Automobile Association
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Ottawa, Ontario
K2C 3J2
(613) 226-7631

Publications

Used Car Buyers Guide: A Reliability Survey of Popular Domestic and Imported Used Cars, 1982 Edition, \$3.00.

Car Costs, 1982.

Autopinion sheets for a variety of vehicle makes and models.

Canadian Motor Coach Association

Background

The Canadian Motor Coach Association was established in 1936 as a voluntary grouping of bus companies providing inter-city bus service. The membership now includes 12 Operating Member companies and 24 Affiliated and Associated members. The objectives of the Association are the acquisition, compilation and distribution of information and data of value to motor coach operators throughout Canada. It also represents the inter-city coach industry in respect to all public matters of general concern and prepares submissions required for such representation to regulatory bodies.

Projects

The intercity bus operates do not carry on any joint energy R&D activities through the Canadian Motor Coach Association.

Contact Person

Donald C.S. Edwards
Executive Director
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Suite 1310
112 Kent Street
Ottawa, Ontario
K1P 5P2

Canadian Trucking Association

Background

The Canadian Trucking Association (CTA) is a federation of regional trucking associations and represent the for-hire portion of the trucking industry. Energy conservation techniques and national concerns with availability, pricing, and taxation of transportation fuels are issues which the CTA follows closely.

Projects

- (i) Published booklet entitled "Saving fuel with truck drag-reduction devices". This booklet was prepared with the financial assistance of Transport Canada.
- (ii) Published booklet entitled "Trucker's Guide to Energy Conservation". This booklet was prepared with the financial assistance of Transport Canada.
- (iii) CTA participates in the steering committee for Transport Canada's rolling resistance study. (Phase I is complete; Phase II in progress - Davis Engineering is the contractor).
- (iv) CTA is on the advisory board for the Truck Outreach Program (EMR and Manitoba Government).
- (v) Involved in the planning of Transport Canada's Commercial Vehicle Driver Performance Improvement Study (a three phase study of which the first phase is complete; Phase I - current driver training, Phase II - appropriate techniques of driver training, Phase III - implementation of training methods.)
- (vi) CTA sits on Fuel Committee and Middle Distillate Committee of Canadian General Standards Board.
- (vii) CTA has an Energy Committee that watches developments with respect to price, availability and fuel conservation and responds as required to issues. The Energy Committee has worked with EMR's Energy Supplies Allocation Board expressing CTA's concerns with the allocation plans.
- (viii) Study prepared for CTA by R.F. Webb Corporation Ltd. entitled "Fuel and Engine Developments: A Report to the Canadian Trucking Association", May, 1982.

Canadian Trucking Association (continued)

Contact Person

W. Cameron McLeod
Associate Executive Director
Canadian Trucking Association
130 Albert Street, Suite 300
Ottawa, Ontario
K1P 5G4
(613) 236-9426

Publications

Booklets noted in (i) and (ii) above are available from the CTA.

Canadian Urban Transit Association

Background

CUTA is a national association of urban transit operators, government agencies, suppliers, consultants, educational institutions, and individuals interested in public transit. Objectives include representation of the industry in all public matters of general concern to it, acquisition, compilation and distribution of general information and data of value to the transit industry, and promotion of appropriate research in transit and related fields.

Projects

CUTA is not directly involved in energy research and development relating to transit systems; however, staff are familiar with interests of members, and contact with the Association might assist in determining whether any transit operators had interest or experience in specific research areas (e.g., alternative fuels). One energy-related area in which the CUTA has had direct involvement is the matter of fuel supply allocation and the implications of Energy Supply Allocation Board regulation in a period of fuel supply shortfall.

Consideration is currently being given by the CUTA to a project to investigate transit R&D activity. The expectation is that a comprehensive inventory of transit R&D activity in Canada will be compiled, and that recommendations will be formulated for subjects requiring greater research effort, and for information exchange procedures.

Of possible use to energy researchers is the Association's annual compilation of operations data on transit systems. The publication includes data on fuel consumption by type for each system, and complementary data on ridership, revenue, costs, equipment, passenger miles, etc.

Contact Person

Al Cormier, Executive Director
Canadian Urban Transit Association
301 - 235 Eglinton East
Toronto, Ontario M4P 1K5
(416) 481-3309

Publications

Canadian Urban Transit Association, "Transit Fact Book", Annual.

Canadian Urban Transit Association, "The Current Status of Urban Transit R&D in Canada", November 1982. 70 pp. approx. The report includes a partial listing of R&D projects underway in early 1982, and is a basis for the Association's consideration of a more comprehensive investigation.

Dominion Marine Association

Background

The Dominion Marine Association (DMA) is an association of 19 member companies with more than 175 vessels, the majority of which ply their trade on the Great Lakes system. DMA companies employ more than 6,000 crew and on-shore staff; the fleet of member companies has an overall carrying capacity of more than 3 million tonnes, representing over \$3 billion in investment and carries cargo on the lakes worth \$7 billion annually. Fuel represents some 40 to 45 percent of operating costs for vessels and hence fuel conservation is an important issue to marine operators.

Projects

- (i) Through Transport Canada's Marine Advisory Board, the DMA and its members provide input with respect to desirable R&D projects.
- (ii) Member companies have changed their ship designs and operating practices to save fuel wherever possible, examples include:

for existing vessels:

- bottom paint - new paints have been developed that reduce drag and hence reduce fuel consumption.
- re-engining with low speed diesels.

for new diesels:

- use low speed fuel-efficient diesel engines.
- improved hull designs which improve the flow of water to the propellor.
- waste heat from diesel engines is now used to replace other on-board fuel requirements.

Contact Person

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Dominion Marine Association
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Motor Vehicle Manufacturers' Association

The Motor Vehicle Manufacturers' Association represents major Canadian motor vehicle manufacturers in presenting common views and policies to government and the public. Membership includes:

Amercian Motors (Canada) Inc.
Ford Motor Company of Canada, Limited
General Motors of Canada Limited
International Harvester Canada Limited
Mack Canada Inc.
Paccar of Canada Ltd.
Volvo Canada Ltd.
Western Star Trucks Inc.

While the Association initiates no relevant research or statistical compilations of its own, it does provide for discussion of matters of common interest to members through a number of committees in which each manufacturer is represented. Matters pertaining to energy research could be included in discussions of the Energy Efficiency Committee and the Engineering Committee. Also, members of these committees would tend to be useful contacts in energy related matters in their employers' companies.

Contact Person

Norman A. Clark, Vice President
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Toronto, Ontario
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Private Motor Truck Council of Canada

Background

The Private Motor Truck Council (PMTC) of Canada was formed by a group of major corporations to represent the interests of owners and operators of private motor trucks in Canada engaged in primary commercial enterprises other than for-hire transportation. It is an independent, not-for-profit corporation intended to be national in scope.

The Council seeks active participation by any company distributing or transporting property by motor truck, either as an owner or lessee, in the course of its normal commercial business. It is designed to give these companies an effective voice in the framing of government legislation and regulations and provide them with information, education and training services.

One of the objectives of the Council is to provide a resource and information centre for private motor truck operators, which will provide materials on operations and maintenance of vehicles, cost and energy saving techniques, methods of management and regulations affecting trucking activity.

Projects

- (i) The PMTC is currently working with the Energy Supply Allocation Board and the Energy Sector of EMR to develop an assessment of the impact on service of an emergency allocation plan.
- (ii) The PMTC participates in Ontario's Truck Save, a joint government/industry committee dealing with energy conservation in the trucking industry. PMTC also sits on the committee advising on the Truck Outreach program (EMR & Manitoba Government).
- (iii) The PMTC has an energy and conservation committee; no research activities in progress and none contemplated at the present time.

Private Motor Truck Council of Canada (continued)

Contact Persons

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APPENDIX A

Letter to Interviewees
and
RTAC Letter of Introduction

CANADIAN RESOURCECON LIMITED ECONOMIC CONSULTANTS

LETTER TO INTERVIEWEES

Dear Sir:

At the present time there is no single document which a researcher interested in energy related transportation R&D can consult for a list of individuals/organizations and their current research programs. Transport Canada and Energy, Mines and Resources Canada, in conjunction with the Roads and Transportation Association of Canada, has commissioned Canadian Resourcecon Limited to complete a survey of the energy related transportation research, development and demonstration activity in Canada.

Our intention is to conduct personal interviews with individuals and organizations who are active in the transportation energy R&D field in order to obtain information of their activities.

I will be telephoning you in about a week and I would hope to arrange an interview with you during the week of _____. I expect that the interview will take an hour to an hour and a half and I will ask for details of your R&D activities under the following headings:

- (i) general programs and description
- (ii) specific projects and brief descriptions
- (iii) documentation available
- (iv) contact persons
- (v) budgets, expenditures
- (vi) cooperative research with other organizations
- (vii) future plans

I would emphasize that programs and projects of interest in the survey are programs of transportation R&D where the primary purpose is energy related.

Thank you for your attention and I look forward to meeting you and discussing your transportation energy R&D activities with you.

Yours very truly,

G.A. Constable
Vice-President

GAC/fh
Encl.

February 1, 1983

TO WHOM IT MAY CONCERN

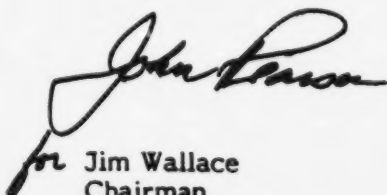
Re: Energy Related Transportation Research,
Development and Demonstration Activity

The Roads and Transportation Association of Canada (RTAC), through its Technical Committee on Transportation and Energy, recognizes the need for a survey of the energy related transportation research, development and demonstration activity in Canada. Transport Canada and Energy, Mines and Resources Canada, as members of the RTAC committee, have agreed to fund and manage a survey.

The survey will result in a compendium of the individuals and organizations which are active in transportation energy R&D and a description of their activities. The compendium will be a useful document to researchers and policy analysts with an interest in this topic; a wide distribution of the compendium is planned.

RTAC, Transport Canada, and Energy Mines and Resources Canada ask that you cooperate with Canadian Resourcecon Limited the consultant who will be conducting interviews and preparing the compendium.

Yours very truly,



Jim Wallace
Chairman
Transportation and Energy Technical Committee

JW/fh

Subject Index

Institutions, agencies and one line descriptions of projects are listed under the following topics and mode headings:

<u>Topics</u>	<u>Page</u>
Alternative Fuels	139
- Fuel Use	139
- Fuel Production	141
- Demonstration Projects	142
Data Collection & Analysis	144
Fuels	146
- Testing	146
- Quality Issues	147
- Demand Forecasting	147
Energy Conservation	148
- General	148
- Vehicle Operations	150
- Road Construction (Materials, Lighting, etc.)	152
Engine Design and Development	154
Vehicle Design and Development	157
 <u>Modes</u>	
Automobiles	158
Trucks	159
Bus	160
Transit	160
Rail	161
Air	162
Marine	163

Alternate Fuels - Fuel Use

Page

Transport Canada - Transportation Development Centre

14

- rail electrification studies
- non-petroleum energy sources for urban transit
- development of propane vehicles
- optimization of propane engine
- propane/diesel engine development
- nickel-zinc batteries
- vehicle battery R&D

Transport Canada - Road Safety Directorate

17

- vehicle safety standard for LPG & CNG
- safety standards and regulation for alcohol fuelled engines
- methanol blend in current autos
- methanol/gasoline fuel emulsifer
- low temperature performance of alcohol fuelled autos

Transport Canada - Energy Planning Directorate

18

- investigation of market potential for CNG
- investigation of propane as an alternative motor vehicle fuel
- investigation of the potential use of alcohols
- comparative assessment of conventional and alternative transportation fuels

EMR

21

- propane grant program
- CNG grant program
- CNG centre at B.C. Research

NRC - Division of Energy R&D

24

- hydrogen utilization
- electric energy storage

B.C. Government

30

- alternate fuels for automotive vehicles in B.C.
- Methane: Fuel for the Future conference
- CNG conversion training
- CNG promotion
- Diesel/CNG testing on truck

B.C. Research

33

- research centre for CNG

<u>Alternate Fuels - Fuel Use</u> (continued)	<u>Page</u>
Alberta Government	35
- Neo-ken electric motor development	
- propane vehicle evaluation	
- fleet market for propane study	
Saskatchewan Government	39
- CNG/diesel testing	
Manitoba Government	
- Winnipeg Transit - conversion to non-petroleum power sources	43
Manitoba Research Council	46
- low temperature starting trials - propane	
- survey of corrosion vis-a-vis methanol fuel	
Ontario Government	47
- Transportation Energy Management Program (TEMP)	
- hydrogen	
- propane	
- CNG	
- methanol	
- LNG as transit bus fuel	
Ontario Research Foundation	54
- methanol/diesel emulsification	
- methanol use in spark ignition engine	
- propane conversion kit tests	
- Agriculture Canada - biomass fuelled tractor	
Quebec Government	56
- general study of alternate fuels	
- conversion of government vehicles to propane, to CNG	
New Brunswick Government	58
- electric commuter car	
- lithium battery development	
- hybrid electric car	
Nova Scotia Government	61
- propane vehicles	

Alternate Fuels - Fuel Use (continued)

Page

Newfoundland Government	64
- propane vehicles	
Canadian National	68
- propane vehicles	
Chrysler Canada Limited	82
- propane technology	
Ford Motor Company of Canada Limited	88
- alternate fuels research	
General Motors	90
- propane technology	
Urban Transportation Development Corporation	96
- hydrogen bus	
- LNG for transit buses	
- diesel/natural gas engine	
University of British Columbia - Mechanical Engineering	100
- alternative fuels laboratory	
- CNG combustion work	
- natural gas/diesel	
Canadian Energy Research Institute	102
- alternative transportation fuels	
Canadian Institute for Guided Ground Transport	108
- rail electrification	
- alternate fuels	

Alternate Fuels - Fuel Production

B.C. Government	30
- alcohol fuel production from wood biomass	
Saskatchewan Research Council	42
- alternate fuels from biomass (milkweed & canola oil)	

Alternate Fuels - Fuel Production (continued)

Page

Manitoba Research Council	46
- biomass fuels	
Ontario Energy Corporation	52
- transportation fuels from wood residues	
PEI Government	63
- ethanol from cull potatoes	
Canadian Methanol Canadien	79
- Renfrew project	
Canertech Inc.	80
- ethanol from cellulose program	
- methanol from wood	
Canadian Energy Research Institute	102
- alternative supplies of oil and their costs	
- methanol development options	
- methanol costs vs. oil sands costs	
Technical University of Nova Scotia - Centre for Energy Studies	119
- ethanol from potatoes	

Alternate Fuels - Demonstration Projects

EMR	21
- CNG demonstration program	
B.C. Research	33
- CNG fleet	
Saskatchewan Government	39
- propane vehicles in use	
- CNG vehicles in use	
Manitoba Government	43
- gasohol and propane fleet test	
- methanol vehicle fleet test	

Alternate Fuels - Demonstration Projects (continued)

Page

Ontario Government

47

- Drive Propane demonstration
- Methanol tests

Ontario Research Foundation

54

- methanol blend demonstration
- diesel/methanol emulsification work
- diesel/methanol fumigation work
- methanol vehicle demonstration

Canadian Methanol Canadien

79

- retail methanol station
- demonstration fleet

Data Collection & Analysis

Page

Transport Canada - Road Safety Directorate	17
- monitor and assess trends in vehicle fuel consumption	
- on-board auto/truck fuel data acquisition	
Transport Canada - Energy Planning Directorate	18
- data base development for heavy truck fuel consumption	
Transport Canada - Economic Analysis Directorate	19
- intercity passenger and freight energy study	
- survey methodology development - private trucking and for-hire trucking	
EMR	21
- data base studies	
Saskatchewan Government	39
- comparative testing of CNG and gasoline-equivalency between fuels	
- on-board monitoring - truck fuel consumption	
Ontario Government	47
- data analysis	
Quebec Government	56
- data bank of transportation energy statistics	
Canadian Pacific Limited	70
- on-board instrumentation of fuel consumption	
Du Pont Canada Inc.	85
- ESCON forecast model	
Ethyl Canada Inc.	86
- fuel and car trends forecasts	
University of Toronto - York University - Joint Program in Transportation	105
- household data re automobile ownership	
University of Montreal - Centre de Recherche sur les Transports	114
- measuring the fuel cost of urban congestion	
- Winnipeg automobile ownership analysis	

Data Collection & Analysis (continued)

Page

University of New Brunswick - Transportation Group

118

- highway cost allocation study
- role of the broker in for-hire trucking
- truck costs in forestry sector

Canadian Automobile Association

125

- autopinion
- vehicle durability survey

Canadian Urban Transit Association

130

- transit fact book

Fuels - Testing	<u>Page</u>
Transport Canada - Transportation Development Centre	14
- medium-speed diesel combustion research (rail)	
Transport Canada - Energy Planning Directorate	18
- inventory of fuel/engine testing facilities	
NRC - Division of Mechanical Engineering	23
- general studies	
DND	26
- gas turbine engine combustion - oil sands based fuels	
- diesel engines with degraded diesel fuels	
- gas turbine research	
- in-house laboratory facilities	
B.C. Research	33
- laboratory facilities - CNG testing	
Alberta Research Council	38
- fuel testing laboratory	
Ontario Research Foundation	54
- engine laboratory	
- fuel testing work	
Canadian National	68
- blending bunker oil with diesel	
Canadian Pacific Limited	70
- locomotive engine testing (AAR)	
Bombardier	75
- tar-sand based fuels evaluation	
Du Pont Canada Inc.	85
- gasoline additives research	
Ethyl Canada Inc.	86
- gasoline additives research	
- combustion technology	
- cetane boosting	

Fuels - Testing (continued)

Page

Laval University - Mechanical Engineering

116

- combustion modelling by computer
- oil sands fuels in aircraft engines
- combustion research on 40 fuels
- addition of methanol, ethanol and isopropanol to automotive fuels

Fuels - Quality Issues

EMR

21

- lead phase-down

NRC - Division of Mechanical Engineering

23

- diesel fuel quality

DND

26

- diesel and gas turbine engine combustion on degraded fuels

Canadian National

68

- blending bunker oil with diesel

Canadian Pacific Limited

70

- syncrude replacing diesel

Canadian Institute for Guided Ground Transport

108

- railway diesel from coal

Fuels - Demand Forecasting

Transport Canada - Energy Planning Directorate

18

- investigation of market potential for CNG
- investigation of propane
- investigation of the potential use of alcohols
- comparative assessment of conventional and alternative transportation fuels

EMR

21

- data base studies and fuel demand models

Du Pont Canada Inc.

85

- ESCON forecast model

Ethyl Canada Inc.

86

- fuel and car trends forecasts

Energy Conservation - General

Page

Transport Canada - Transportation Development Centre

14

- rail car insulation standards
- rail car power management
- intercity bus fuel efficiency
- articulated intercity bus
- signal system optimization package
- inflatable fairings on trucks
- fuel efficient STOL aircraft
- small transport aircraft fuel efficiency

Transport Canada - Road Safety Directorate

17

- evaluation of techniques to improve energy efficient driving behaviour
- energy conservation through improved traffic operation measures
- commercial vehicle driver training
- engine efficiency improvements (fan and accessory decoupling clutch)

Transport Canada - Energy Planning Directorate

18

- assessment of energy conservation options
- impact of government policies upon transportation energy efficiency

EMR

21

- pre-emergency measures
- Canadian airline industry energy management
- truck outreach program
- fuel conservation by mode
- urban and regional R&D

ITC

28

- Industrial Energy R&D program
- Enterprise Development program

Manitoba Government

43

- vanpooling
- route optimization study
- drive-save and truck-save
- truck outreach program
- future activities

<u>Energy Conservation - General</u> (continued)	<u>Page</u>
Ontario Government	47
- Transportation Energy Management Program (TEMP)	
- municipal program	
- Drive-Save	
- Share-a-ride (vanpools)	
- teleconferencing	
Ontario Energy Corporation	52
- Ontario Van Pool Organization Ltd.	
- Teleride and SAGE projects	
Quebec Government	56
- ride-sharing	
New Brunswick Government	58
- maximum speed limit study	
- vanpooling	
Nova Scotia Government	61
- vanpooling	
- overview study of fuel substitution opportunities	
- Teleride	
PEI Government	63
- vanpooling	
- automobile tuning for fuel conservation	
Canadian National	68
- energy conservation in buildings	
University of British Columbia - Centre for Transportation Studies	99
- energy for transportation	
University of Calgary - Institute for Transportation Studies	101
- energy conservation in urban commodity flow	
- automobile energy conservation-urban	
University of Manitoba - Centre for Transportation	104
- price elasticity of air travel	
- urban density, travel distance, and energy consumption	

Energy Conservation - General (continued)

Page

University of Toronto - York University - Joint Program in Transportation	105
- energy consumption of alternative transport systems	
- energy efficiency in transport	
Canadian Institute for Guided Ground Transport	108
- modal selection - coal movement	
- railway energy conservation	
Carleton University - Transportation Research Centre	110
- intercity rail/bus energy efficiency	
- telecommunications	
- energy efficiency - intercity passenger	
- urban systems	
University of Montreal - Centre de Recherche sur les Transports	114
- measuring the fuel cost of urban congestion	
- Winnipeg automobile ownership analysis	
- freight commodity flow in Brazil	
University of New Brunswick - Transportation Group	118
- energy intensity of regional airports	
Air Transport Association of Canada	124
- energy management in Canadian airline industry	

Energy Conservation - Vehicles Operations

Transport Canada - Road Safety Directorate	17
- evaluation of low temperature fuel economy	
- on-board auto/truck fuel data acquisition	
- truck rolling resistance measurement system	
B.C. Government	30
- tune-up program	
- general conservation actions	
Alberta Government	35
- testing vehicle retrofit devices	

<u>Energy Conservation - Vehicles Operations (continued)</u>	<u>Page</u>
Saskatchewan Government	39
- diesel units replacing gasoline units	
- recycle hydraulic oil	
- used lubricating oil added to diesel fuel	
- driver training	
Manitoba Government	43
- routine optimization study	
Ontario Government	47
- Transportation Energy Management Program (TEMP)	
- Truck-Save	
New Brunswick Government	58
- changes to government vehicle fleet	
Nova Scotia Government	61
- waste oil as diesel fuel	
- commuter parking lots	
- automobile tuning for fuel conservation	
Air Canada	66
- aircraft operating procedures, equipment modifications	
- aircraft performance management system	
- new more fuel efficient equipment	
Canadian National	68
- improved fuel management system	
- train speed vs. fuel consumption	
- friction reducing lubricating oils	
Reimer Express Lines Ltd.	72
- fuel conservation techniques	
Voyageur Inc.	73
- reduced bus speeds	

Energy Conservation - Vehicle Operations (continued)

Page

Canadian Fram Limited	77
- energy efficient engine componentry	
Massey-Ferguson Limited	93
- improved operating efficiency of farm machinery	
Urban Transportation Development Corporation	96
- diesel transit bus market study	
University of Manitoba - Centre for Transportation	104
- fuel economy (large trucks)	
Technical University of Nova Scotia - Centre for Energy Studies	119
- automobile tuning for fuel conservation	
Canadian Automobile Association	125
- operation tune-up	
Canadian Trucking Association	128
- booklets - drag reduction devices and fuel saving guide	

Energy Conservation - Road Construction (Materials, Lighting, etc.)

Alberta Government	35
- recycling asphalt materials	
Saskatchewan Government	39
- highway design, highway construction materials	
Quebec Government	56
- road maintenance techniques (recycling asphalt, etc.)	
- construction materials (asphalt mixes)	
- roadway lighting research	

Energy Conservation - Road Construction (Materials, Lighting, etc.)
(continued)

Page

New Brunswick Government

58

- emulsion asphalts, asphalt alternatives, asphalt recycling
- highway design
- field procedure changes
- main highway shoulder construction
- low pressure sodium lamps
- highway sign project
- energy efficient maintenance buildings

University of Montreal - Civil Engineering

112

- refinement of ICES program
- asphalt mixes
- shale as an aggregate in road construction

Engine Design and Development**Page**

Transport Canada - Transportation Development Centre	14
- A.C. traction motors for locomotives - Stirling cycle locomotive engine - Shunter locomotive study - optimizing propane engines - propane/diesel engine development - DISC engine feasibility - mixed flow turbine study (aircraft) - gas turbine ceramics technology (aircraft)	
Transport Canada - Road Safety Directorate	17
- engine efficiency improvements (fan and accessory decoupling clutch)	
EMR	21
- evaluation fuel engine systems	
NRC - Division of Mechanical Engineering	23
- vehicular engine cooling dynamics - hydraulic/diesel bus	
DND	26
- cold starting diesel engine with plasma plugs	
ITC	28
- Industrial Energy R&D program - Enterprise Development program	
Ontario Energy Corporation	52
- carburetion system	
Ontario Research Foundation	54
- spark ignition engine conversion to stratified charge - Agriculture Canada - biomass fuelled tractor	
Canadian Pacific Limited	70
- Bombardier - new locomotive program	

<u>Engine Design and Development</u> (continued)	<u>Page</u>
Bombardier	75
- single cylinder engine for test purposes	
- development of new freight locomotive	
Canadian Fram Limited	77
- pulley control devices	
- electromechanical interfacing	
- fan design	
- non-ram engine cooling	
Chrysler Canada	82
- proprietary research	
Cummins Diesel of Canada Limited	84
- improved cooling system (reduce paristic losses)	
- exhaust manifold design	
- turbocharging	
- adiabatic combustion	
- timing control systems	
Ford Motor Company of Canada Limited	88
- conceptual research	
- transmissions, torque converters, rear ends	
- engine research	
General Motors of Canada	90
- engine improvements	
International Harvester Canada Limited	91
- engine cooling	
KHD Canada Inc.	92
- development of air cooling diesel for medium trucks	
Massey-Ferguson Limited	93
- diesel engine improved efficiency of diesel engines	
- combustion chamber design	
- fuel injectors	
- reduction of parasitic engine losses	
- lubricants	

<u>Engine Design and Development</u> (continued)	<u>Page</u>
Pratt & Whitney Aircraft of Canada Limited	95
- gas turbine engines (aircraft)	
Urban Transportation Development Corporation	96
- flywheel energy storage	
- LNG engines for transit buses	
- diesel/natural gas engine	
- fuel cells	
University of Manitoba - Centre for Transportation	104
- electric drives (street cars, trolleys)	
Canadian Institute for Guided Ground Transport	108
- magnetic levitation, linear synchronous motors	

Vehicle Design and Development

Page

Transport Canada - Transportation Development Centre

14

- compliant air bearings (SAIL Rail)
- hybrid road vehicle development
- diesel/flywheel hybrid drive train
- augmentor wing cruise performance study

ITC

28

- Industrial Energy R&D program
- Enterprise Development program

Canadian Pacific Limited

70

- reduce tare weight of rolling stock
- steerable trucks (rail car)

Voyager Inc.

73

- energy efficient bus

Chrysler Canada

82

- proprietary research of vehicles

Ford Motor Company of Canada Limited

88

- aerodynamics
- weight reduction and down sizing

Urban Transportation Development Corporation Limited

96

- ICTS & light street cars
- flywheel energy storage
- SAIL Rail

Automobiles	<u>Page</u>
Transport Canada - Road Safety Directorate	17
- monitor and assess trends in fuel consumption	
- on-board auto/tractor fuel data acquisition	
Quebec Government	56
- role of the automobile study	
Canadian Fram Limited	
- energy efficient engine componentry	
Chrysler Canada Limited	82
- proprietary research on vehicles	
- alternate fuels	
Ford Motor Company of Canada Limited	88
- conceptual research	
- alternate fuels	
- transmissions, torque converters, rear ends	
- engines	
- aerodynamics	
- weight reduction and downsizing	
General Motors of Canada Limited	90
- engine improvements	
- alternate fuels (propane)	
Technical University of Nova Scotia - Centre for Energy Studies	119
- automobile tuning for fuel conservation	
Canadian Automobile Association	125
- autopinion	
- vehicle durability survey	
- operation tune-up	
Motor Vehicle Manufacturers' Association	132
- no projects	

Trucks

Page

Transport Canada - Road Safety Directorate	17
- monitor and assess trends in vehicle fuel consumption	
- truck rolling resistance measurement system	
Transport Canada - Energy Planning Directorate	18
- data base development for heavy vehicle fuel consumption	
Transport Canada - Economic Analysis Directorate	19
- survey methodology development - private trucking and for-hire trucking	
EMR	21
- estimates of truck fuel consumption	
- truck outreach program	
Saskatchewan Government	39
- on-board fuel monitoring	
Ontario Government	47
- Truck Save	
Canadian Pacific Limited	70
- add-on equipment	
Reimer Express Lines Ltd.	72
- fuel conservation techniques	
International Harvester Canada Limited	91
- engine cooling	
University of Manitoba - Centre for Transportation	104
- fuel economy of large trucks	
University of New Brunswick - Transportation Group	118
- trucking cost in forest industry	
- role of broker in for-hire trucking	

Trucks (continued)

Page

Canadian Trucking Association

128

- booklets - drag-reduction devices and fuel saving guide
- participation - rolling resistance study and EMR Truck Outreach
- vehicle driver performance improvement
- fuel and engine development study

Private Motor Truck Council of Canada

133

- participation - EMR's Truck Outreach & Ontario's Truck Save

Bus

Transport Canada - Transportation Development Centre

14

- articulated intercity bus
- intercity bus fuel efficiency

Voyageur Inc.

73

- energy efficient bus
- reduced speeds

Carleton University

110

- energy efficiency intercity rail/bus

Canadian Motor Coach Association

127

- no projects

Transit

Transport Canada - Transportation Development Centre

14

- non-petroleum energy sources for urban transit

Transit (continued)

Page

Urban Transportation Development Corporation

96

- ICTS and light street car systems
- hydrogen bus
- diesel transit market study
- SAIL Rail

Canadian Urban Transit Association

130

- transit fact book

Rail

Transport Canada - Transportation Development Centre

14

- railway electrification studies (Cartier Railway, B.C. Rail)
- A.C. traction motors for locomotives
- Stirling Cycle locomotive engine
- medium-speed diesel combustion research
- shunter locomotive study
- rail car insulation standards
- rail car power management

Canadian National

68

- blending bunker fuel with diesel
- train speed vs. fuel consumption
- improved fuel management system

Canadian Pacific Limited

70

- on-board instrumentation of locomotives
- reduce tare weight of rolling stock
- syncrude substituted for diesel
- steerable trucks
- electrification studies
- Bombardier new locomotive program

Bombardier

75

- tar sands based fuel evaluations
- single cylinder engine for test purposes
- development of new freight locomotive

Rail (continued)

Page

Canadian Institute for Guided Ground Transport

108

- Arctic Rail Study
- electrification
- alternate fuels
- energy conservation
- modal selection for coal movement

Air

Transport Canada - Transportation Development Centre

14

- mixed flow turbine study
- fuel efficient STOL aircraft
- small transport aircraft fuel efficiency
- augmentor wing cruise performance
- gas turbine ceramic technology

EMR

21

- Canadian airline industry energy management

Air Canada

66

- aircraft operating procedures, equipment modifications
- aircraft performance management system
- new more fuel efficient equipment

Canadian Pacific Limited

70

- fuel efficiency improvement

Pratt & Whitney Aircraft of Canada Limited

95

- gas turbine engines

University of New Brunswick - Transportation Group

118

- energy intensity of regional airports

Air Transport Association of Canada

124

- energy management in the Canadian airline industry

Marine	<u>Page</u>
Nova Scotia Government	61
- Cort nozzle test	
Newfoundland Government	64
- fishing vessel fuel consumption	
Canadian Pacific Limited	70
- slow speed diesels	
- review of conventional fuel conservation techniques	
Canadian Marine Transportation Centre	121
- technical change in the shipping industry	
- marine engine technology	
Dominion Marine Association	131
- changes to ship design and operation	

POOR

QUALITY

ORIGINAL

